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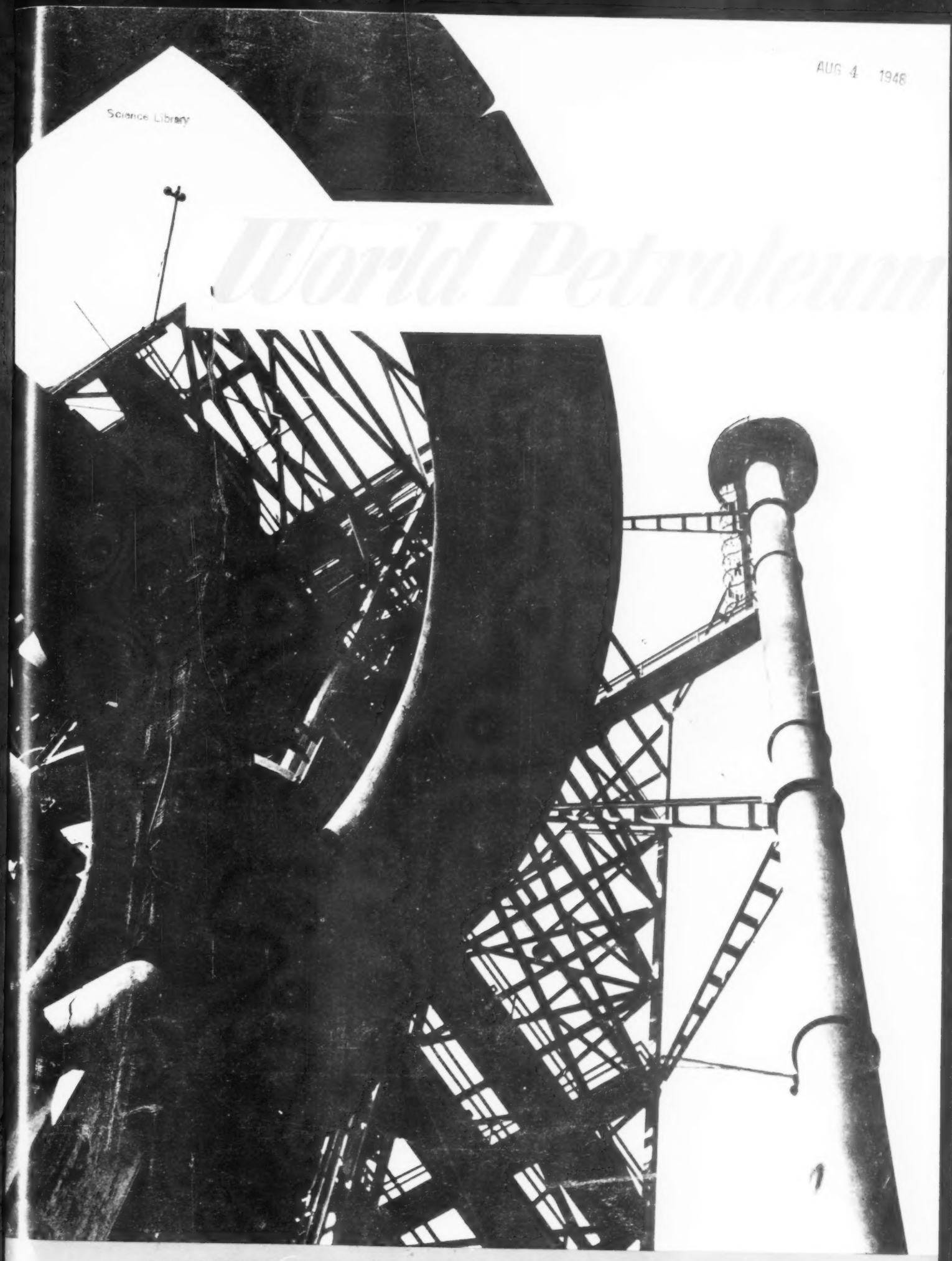
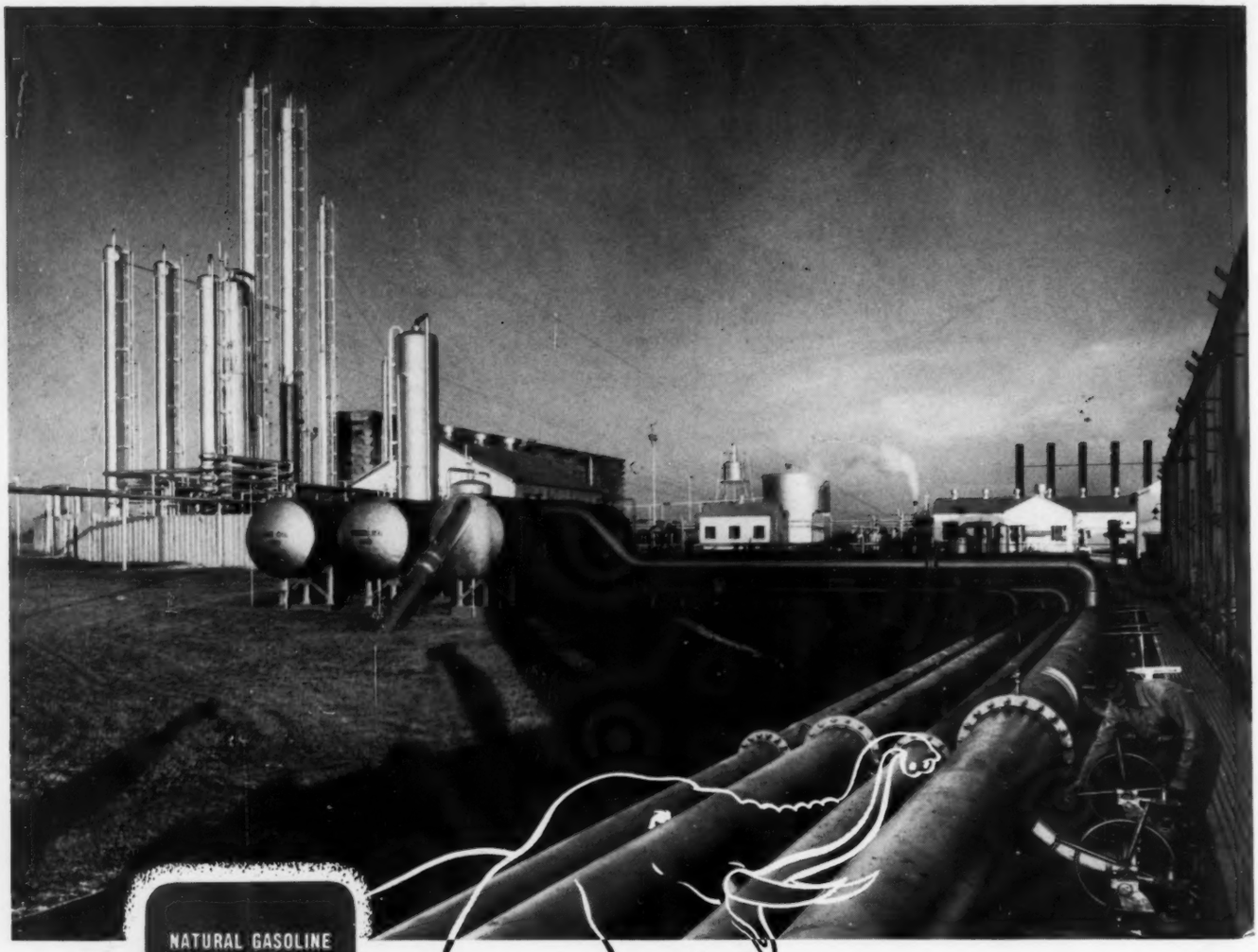


EIGHTEENTH ANNUAL REFINERY ISSUE

FIVE DOLLARS



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Crude Oil, Natural Gasoline and Liquefied Petroleum Products

WORLD PETROLEUM

Founded by Russell Palmer

PUBLISHED BY MONA PALMER

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THIS MONTH'S COVER—Catalytic cracking unit of Union Oil Company of California at Wilmington, Calif. Photograph by Frank Meitz, Los Angeles.

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EDITORIAL

PETROLEUM INDUSTRY IS SAFE IN PRIVATE HANDS

EXAGGERATED forecasts of shortages—predicted shortages of motor fuel last summer and of fuel oil during the late winter of exceptional severity—undoubtedly caused many persons to give credence to the oft-repeated assertion that oil reserves of the United States are rapidly nearing exhaustion. The mere fact that these forecasts were not realized and that inability to satisfy the full demand for these products existed only in a few relatively small areas and was there quickly relieved did not silence the pessimistic predictions.

Next to lack of food, there is nothing more disturbing to the public than the prospect of deprivation of these petroleum products on which the comfort of the individual and the economy of the whole country have come so largely to depend. It was not surprising, therefore, that the mere suggestion of such a possibility should have attracted the attention of Congress and other public bodies and should have led to numerous and diverse inquiries and investigations into all phases of oil industry conditions and operations. While these probes as a whole have revealed nothing discreditable to the industry or alarming to consumers, they afforded an opportunity which was seized upon by theorists who have long sought to impose an increasing measure of federal control upon the operations of the industry. They have taken the occasion to advance their pet idea that the private individuals who have brought the production and processing of oil from its infant dimensions to its present high state as an agency of industrial progress and national security are no longer capable of giving it efficient direction and that the government should be called in to do the job.

Thus we have had proposals, some of them taking the form of bills introduced in Congress, that federal authority should be extended over all phases of oil industry operation, that it should regulate production, distribution and price, that it should take away from the states the ownership of their mineral rights, dictate where wells may be drilled and oil produced and that government itself should enter the oil business by building and operating refining plants.

An element of hysteria, such as usually makes itself manifest in discussion that is uninformed, found expression in demands that the building of diesel locomotives for railway use be forbidden and that no more oil heating installations in homes or industrial plants be permitted. The head of one of the nation's largest administrative departments recommended that the government itself construct ten or more large plants for the production of synthetic liquid fuel. The cost of providing two million barrels daily was estimated at a mere nine billion dollars, although the judgment of experienced engineers is that the actual expenditure required would be three or four times that amount with very great doubt as to the results that would be obtained.

The real answer of the oil industry to the criticism heaped upon it and the impractical proposals put forward is shown in articles contained in following pages of this magazine. Not in response to clamor but in pursuance of carefully formulated plans earlier adopted, the industry is moving to meet the unprecedented upsurge in demand for its products, just as, at the outbreak of war, it marshaled all its resources to meet military requirements previously undreamed of and to help blaze the path to victory. So far from failing to keep pace with the growth in consumptive demand, statistics for the first six months of 1948 show that oil companies of the United States have drilled approximately 20 percent more wells than in the corresponding period of 1947 and have added nearly 25 percent to the number of producing wells brought in. At the same time runs of crude to refinery stills have been raised half a million barrels daily and the stocks of all principal products are higher today than they were a year ago.

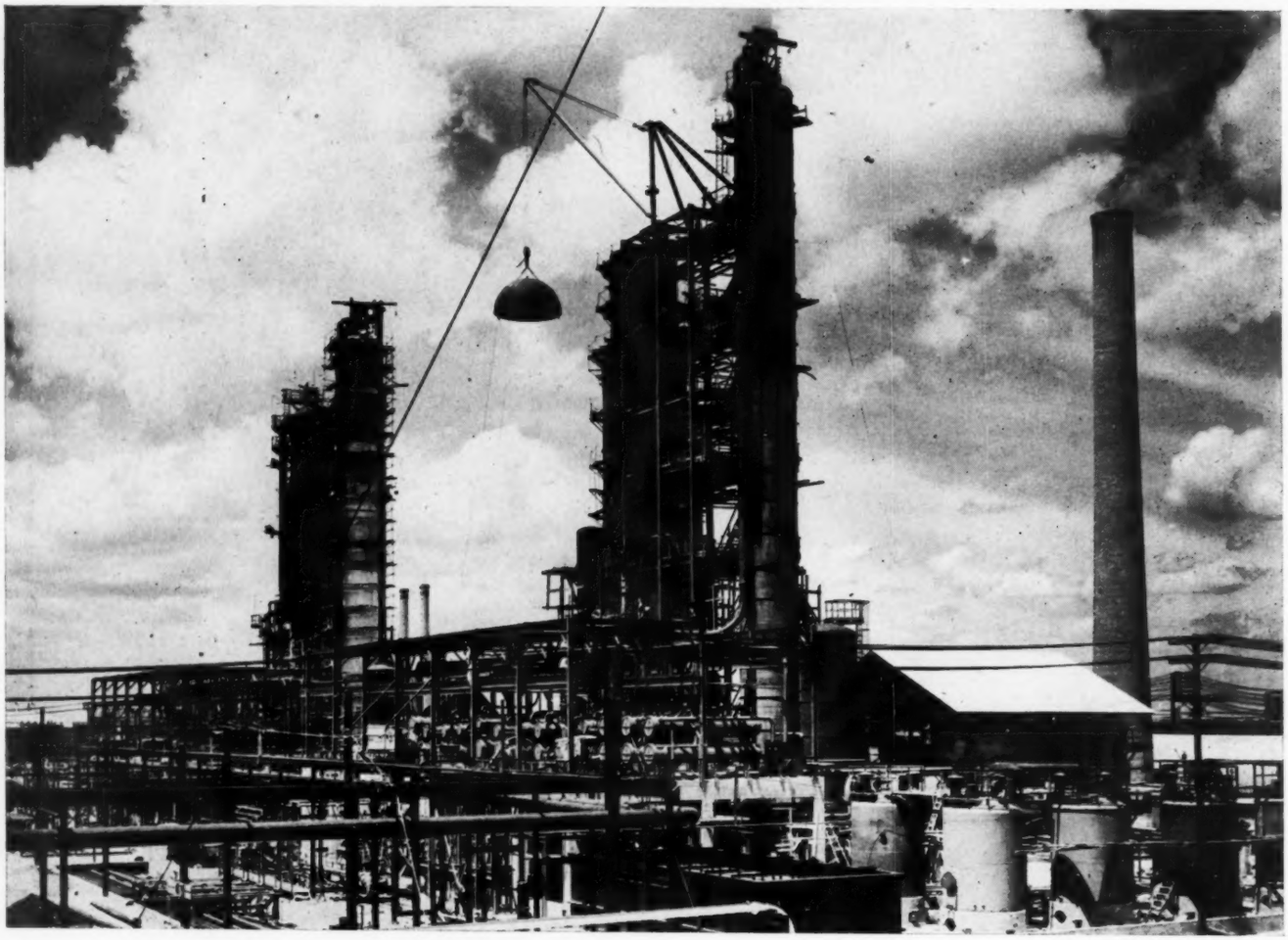
This is but a step in the industry's program which calls for a capital investment of twelve to fifteen billion dollars in a three-year period. More than two billion dollars is being expended annually on the expansion of refining capacity as detailed elsewhere in this issue.

Special concern has been expressed by critics of the oil industry as to its ability to meet the future growth of demand, particularly in the realm of synthetic production, and this found expression in the appropriation by Congress at its recent session of sixty million dollars for fundamental study and pilot plant experimentation in this field. This is praiseworthy action. It represents perhaps one-tenth of the sum that oil companies are devoting yearly to technical investigation, a goodly part of it assigned to this very subject of synthesis.

In scarcely any other industry has effort and expenditure on research risen so rapidly as in the oil industry, as is revealed by the brief account of vast new laboratories and a growing working force which now numbers some fifteen thousand persons, which appears on other pages of this issue.

This is the real story of oil industry retrogression!

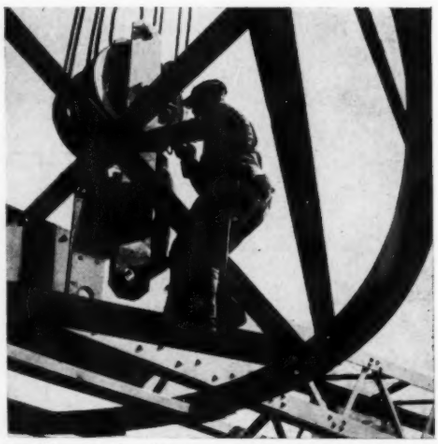
U. S. REFINERIES IN BROAD PROGRAM TO RAISE CAPACITY



Crude distillation units under construction for Gulf Oil Corp. at Port Arthur, Texas. Photo by Robert Yarnall Richie for E. B. Badger & Sons Co., plant contractors.

UNTIL 1945 the greatest task ever undertaken by the oil industry was that of providing the tools of victory in World War II, on the land, in the air and on the sea. To that end all its resources were directed: production was expanded by nearly a million barrels daily; the world's largest pipe lines and its greatest tanker fleet were built; a billion dollars was spent on refinery construction to supply the products demanded for military use. The result of this stupendous effort is now history.

Almost as soon as this work was done and before the readjustment to peacetime operation was complete the industry found itself facing another and as events have proved a still bigger job. It is clear now that the war ushered in a new era in the progress of petroleum. Not only was there the backed-up demand for replacements and new facilities that had gone unsatisfied for half a dozen years but the war itself had developed new products, discovered new uses and



Installing rigging block on boom. Libsohn photo for Standard Oil Co. (N.J.)

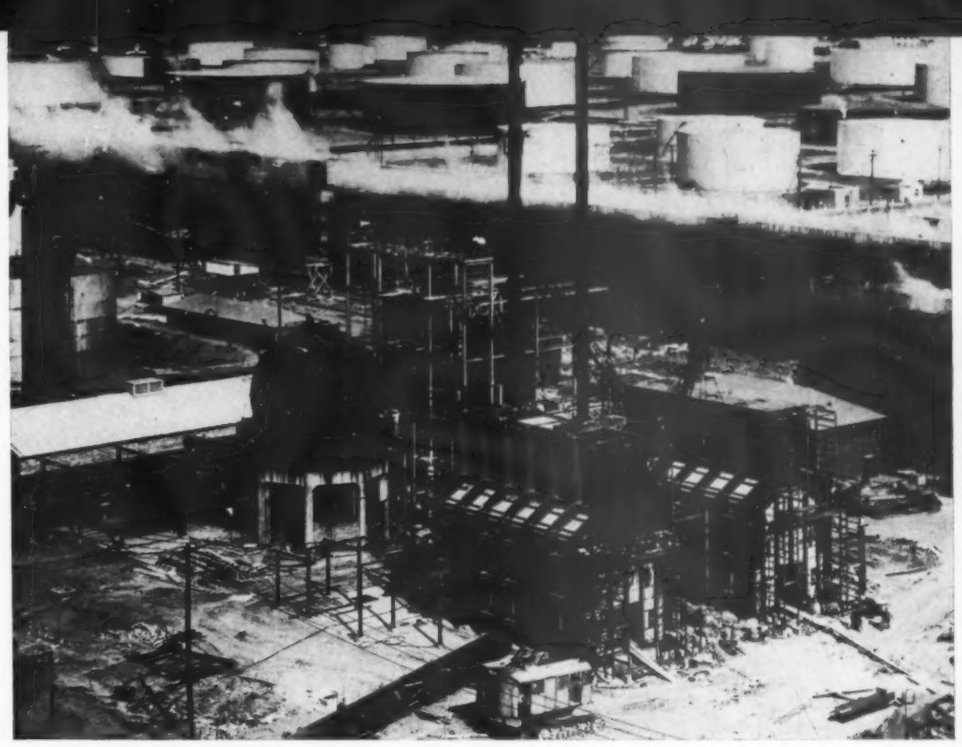
stimulated demand in places where it had been hardly existent previously. The whole world had become oil conscious and hungry for oil products as never before. Not only was the rise in demand without precedent but it was beyond the expectation of the best informed men in the oil industry itself. Only now are its full proportions beginning to be appreciated.

In 1946 many oil companies adopted programs of refinery expansion which at the time seemed fully adequate to care for the rise in consumption that was generally anticipated. Many plants were becoming outdated because of inability to make replacements or additions during the war years except for the manufacture of military supplies. Processes developed during the war called for new installations. There was also the urgent task of replacing or restoring the facilities that had been destroyed or badly damaged in the course of the great combat when oil plants were the favorite target of the contending forces. With these needs clearly in view plans were drawn to a liberal scale and expenditures were projected by American and international companies of some $700 million annually. In

practically every case these estimates have been revised upward, in some instances several times, as construction has proceeded. Today the refining industry is planning in terms of billions and the period over which this rate of expenditure is anticipated has been extended for several years.

Most recent estimates are that the outlay for refinery expansion in 1948 will exceed a billion dollars and that the same rate will need to be maintained for at least three years to keep pace with the rising demand for oil products. Since the investment authorized and publicly announced by some twenty-five American and international companies amounts to three quarters of this gigantic sum the guess appears to be not unreasonable. The one factor that may interfere with its realization is the inability of engineering and equipment firms to obtain the materials necessary and to carry out the volume of construction that is projected. A statement that appears perfectly safe is that the accomplishment of the current year will represent the maximum of which the concerns serving the industry are capable.

In the United States where the upswing in demand for petroleum products in 1947 forced refineries to operate at full load a substantial addition to capacity is being made in 1948 as the result of work begun a year or two years ago. This will be sufficient at least to take care of the growth in market requirements estimated at seven or eight percent while still more extensive construction activity is being put under way for completion in 1949 and 1950. It is noteworthy that these building projects are distributed in all parts of the country in contrast to the trend that for a number of years centered such activity mainly in the Mid-Continent and Gulf Coast areas. Notable additions to capacity are under way in Atlantic Coast plants, and in the Rocky Mountain district, the former presumably in anticipation of growing imports and the latter in recognition of the rising importance of the mountain areas as a producer.

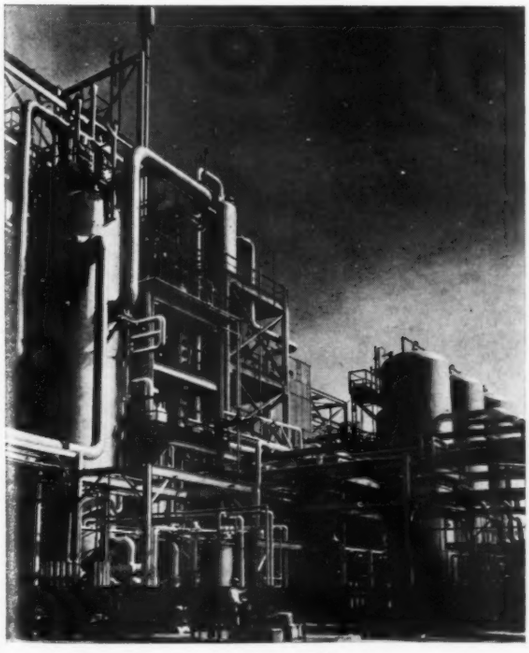


Vacuum flashing unit recently completed at Shell Oil Company's Wood River, Ill., refinery.

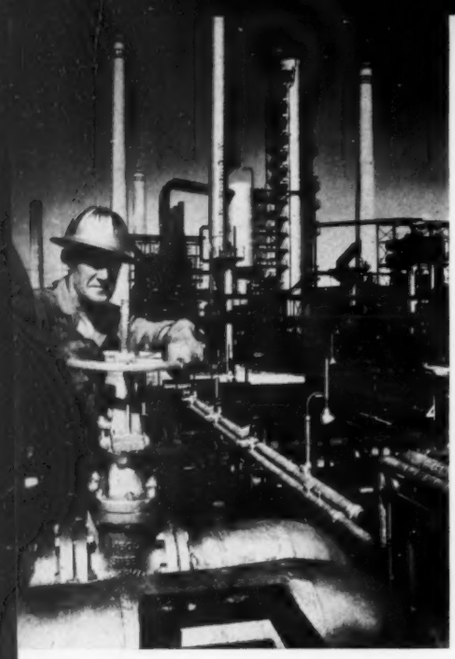
One of the outstanding developments in East Coast refining is the plant of The Texas Co. now being erected at Eagle Point on the Delaware River near the Philadelphia Navy Yard. This will be a completely new refinery occupying a site of 1,368 acres. It will be the company's twenty-first plant and will extend Texas's refining facilities from coast to coast. It will include the latest form of crude distillation and vacuum treating equipment, a fluid catalytic cracking unit and catalytic polymerization facilities, thermal reforming and furfural units for the manufacture of middle distillates. It will be designed to handle high sulfur crudes, either domestic or imported. The plant will have a daily capacity of 40,000 barrels and will represent an investment of $80 million. It is hoped to have it in operation before the end of 1949. In announcing the site Chairman W. S. S. Rodgers of The Texas Co. said that it had been selected as the result of a search extending over two years and had been picked as an advantageous location to receive either domestics or imported crudes.

Also in this Philadelphia area Sinclair Refining Co. has just completed a modernization program at its Marcus Hook refinery. New units include catalytic cracking and vacuum stills, a polymerization plant and expanded utilities. The "cat" cracker has been in operation since March charging up to 25,000 barrels daily of 23 gravity high boiling point gas oil produced by vacuum distillation down to asphalt of diesel

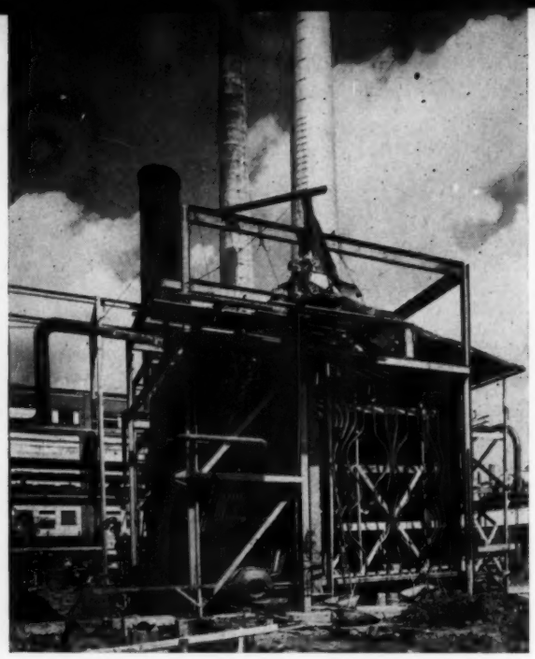
Esso Standard Oil Co. benzol-methyl ethyl ketone plant at Baton Rouge, La.



General view of Humble's MEK plant completed earlier this year at Baytown, Texas. Robert Yarnall Richie photo for E. B. Badger & Sons Co.

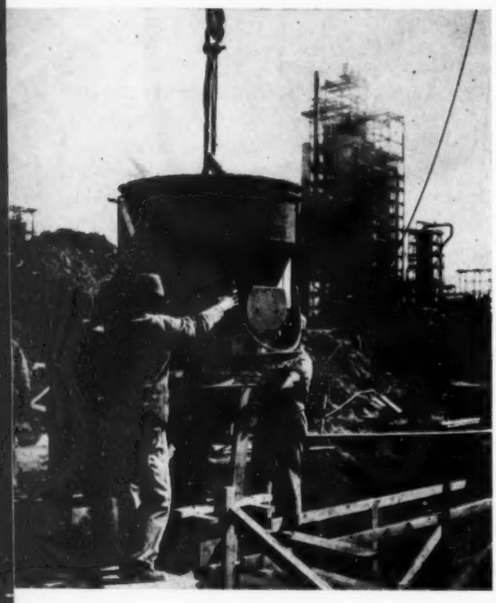


wly completed crude distillation at El Segundo refinery of Standard Oil Co. of Calif.

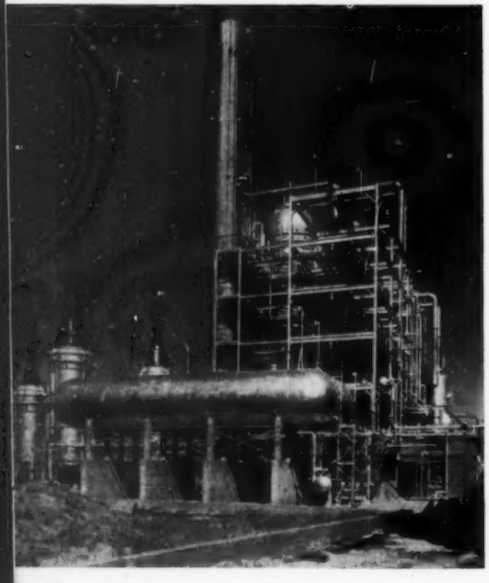


One of five Babcock & Wilcox boiler units being installed at Shell Oil Company's Deer Park, Texas, refinery.

As are many other companies Gulf Oil Corporation is building hundreds of new tanks to help supply peak



uring foundations of new cat cracker for Esso Standard Oil Co. at Linden, N. J. Libsohn photo.



free reduced crude. The unit operates on natural catalyst on a 50-60 percent conversion burning up to 22,000 pounds per day of coke. C_4 to 400° F end point gasoline plus cycle oil yields have averaged better than 95 percent on virgin charge. The unit, equipped with Cottrell Precipitator, has less than one ton per day catalyst loss to the stack and the activity level is maintained at 32-34 D & L activity with less than six tons per day make-up catalyst. The gas recovery unit processing fluid gases is recovering all of the butane fraction and upward of 75 percent of the propanes. These materials are polymerized on a catalytic high pressure polymerization unit where conversion of 90 percent or higher on the olefins is being realized.

Atlantic Refining Co.'s 19,000-barrel Unisol plant has been placed in operation. A 2500-barrel vacuum still produces low melting point wax. A Schutte emulsion deoiling unit of 2,500,-barrel capacity processes slack wax and foots oil to reduce the oil content of charge to wax-sweating ovens, thereby increasing their efficiency and capacity. In this process the charge stock, water and air are emulsified at a temperature below the charge melting points the emulsion is then centrifuged. A rotary vacuum filter reduces the oil content of slack wax before it is oven-sweated. The unit handles approximately 600 barrels daily of low melting slack waxes. Recently completed facilities for propane deasphalting, phenol extraction and MEK dewaxing-deoiling increase the yields and quality of solvent refixed oils and microcrystalline waxes. Enlargement of equipment for production of severe duty greases is taking place.

As part of Sun Oil Co.'s investment of $6,720,-000 in improved refining facilities during the past year a furfural solvent extraction plant and a wax plant were constructed at the Marcus Hook refinery. Propane output was increased

← Furfural solvent extraction plant and vacuum distillation unit installed by Co-operative Refinery Association at Coffeyville, Kansas.

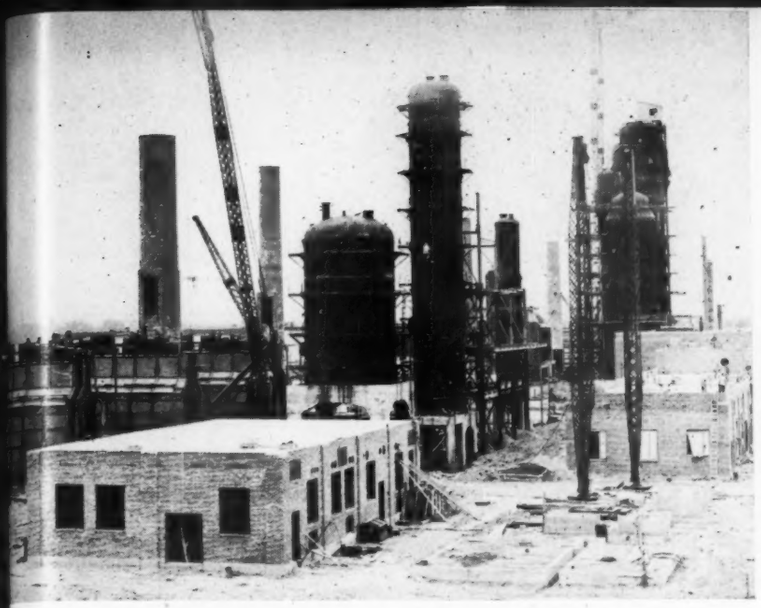
50 percent and extensive packaging and compounding facilities were added.

Gulf Refining Co. is adding a 12,000-barrel vacuum unit together with naphtha and polyform installations to its Philadelphia refinery. Gulf has erected thirty terminal and bulk storage tank installations throughout eastern territory for better distribution of its manufactured products. These tanks have a capacity of some 160 million gallons.

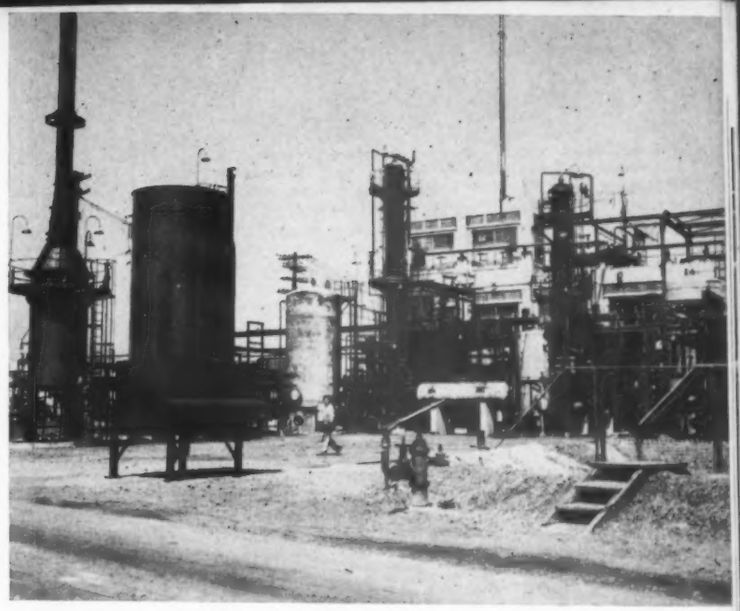
At near-by Paulsboro, New Jersey, which is in the Philadelphia area Socony-Vacuum Oil Co. has installed extended lube oil manufacturing facilities as part of a $35 million improvement program. The units, designed by E. B. Badger & Sons Co., provide furfural solvent refining, benzol, ketone dewaxing, propane deasphalting and contact decolorizing. The plant is expected to be in operation early in 1949.

Standard Oil Co. (N. J.) which according to its annual report spent $426 million in 1947 on expansion in all divisions and expects to raise this above a billion dollars in the current year, will complete early in 1949 the installation of the latest additions to its great Bayway refinery in the New York area. The principal features of a two-year expansion program at this plant are a new pipe still and a fluid catalyst cracking unit.

The vacuum still will have a capacity of 49,000 barrels per stream day and will provide feed stock for the cracking unit. The new fluid catalyst cracker will be the largest ever built with a charge capacity of 41,000 barrels per stream day. It will nearly treble the cracking capacity of the plant, bringing the total charge capacity to some 65,000 barrels daily. To handle the more volatile products of cracking light ends facilities are being suitably enlarged. Construction of a new steam and power plant is under way as part of the plant enlargement and other utilities are being installed.



nt view of construction activity at Cities Service Oil Company's East Chicago refinery where a $28 million program is under way.



Ultrawet manufacturing plant for the production of chemicals from oil at the Philadelphia refinery of Atlantic Refining Co.

At other Esso Standard East Coast refineries particular attention is being given to the increase of product storage capacity. At the Baltimore, Md., refinery which was recently reconstructed tank capacity of 400,000 barrels is being added to meet the demand for heating oil and to accommodate the high refinery throughput of this product. A new grease manufacturing and packaging plant is nearing completion. At Everett, Mass., heating oil and range oil storage is being installed to take care of the heavy seasonal demand for these products. At Bayonne, N. J., an MEK solvent dewaxing plant is planned for completion by 1950 to increase the production of lubricating oils and wax.

In the Central States many enlargements of existing plants are being made to meet the rapidly growing demand in that area. Gulf Refining Co. has under way a thorough modernization of its Cincinnati and Toledo, Ohio, refineries including the addition of fluid catalytic cracking units at both plants and a crude oil distillation unit at Toledo. These improvements are scheduled for completion in 1949. The major reconstruction is being done by E. B. Badger & Sons Co. and M. W. Kellogg Co. Reconstruction and enlargement of tank storage is in charge of Chicago Bridge and Iron Co.

At Toledo, Ohio, Sun Oil Co. is expanding the capacity of its refinery by installation of a crude distillation unit, a 30,000 barrel daily catalytic cracking unit a gas recovery plant, a polymerization unit and facilities for the manufacture of LPG in a two year program at a cost of $16,000,000.

Pure Oil Co. has completed a new coking unit at its Toledo refinery and is installing facilities for the manufacture and storage of special products. At Heath, Ohio, it has erected a fluid catalytic cracking unit to provide the refinery with supplies of higher octane base stock and at Cabin Creek, West Virginia, it is making various improvements including increased loading facilities.

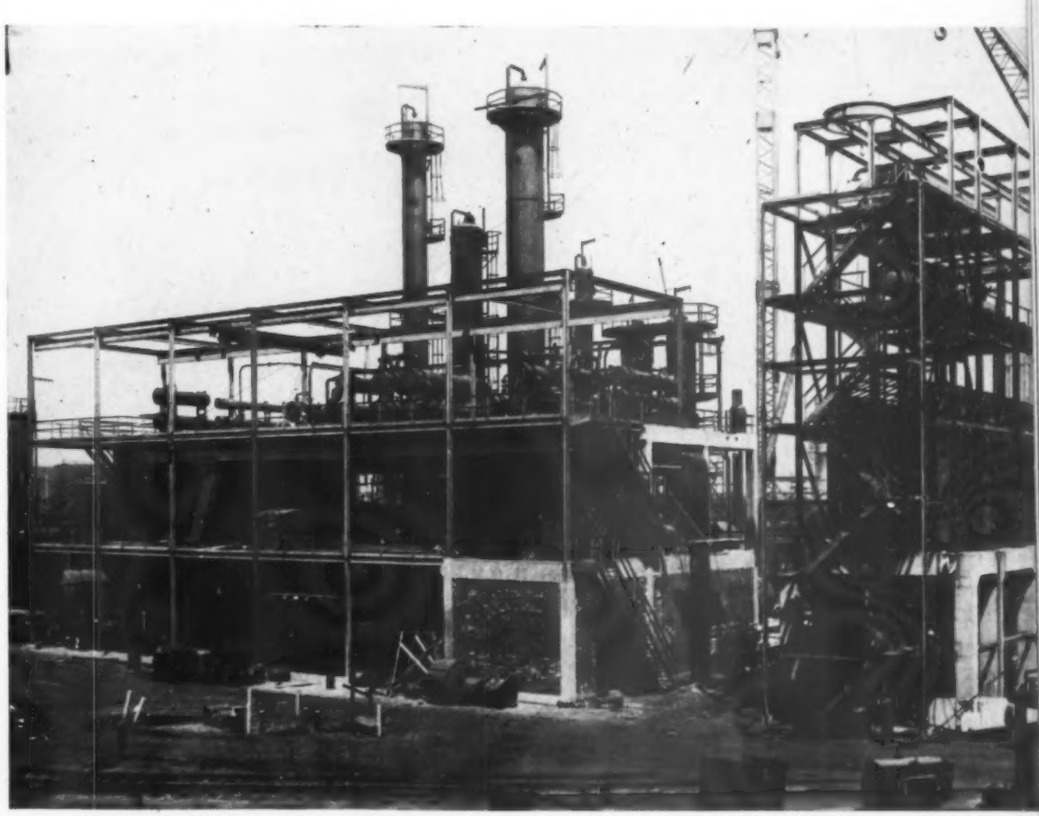
Standard Oil Co. (Ohio) recently made known its intention of rebuilding its plant at Lima, Ohio, at a reported cost of $10 million to include a fluid catalytic cracking unit of 16,000-barrel capacity with absorber and stabilizer designed by Universal Oil Products Co. Construction will be in charge of Arthur G. McKee & Co.

Approaching completion at Robinson, Ill., is the modernization and enlargement of Ohio Oil Co's. refinery. New installations include a two-stage distillation unit, a fluid catalytic cracking unit of 12,400 barrels daily charging capacity, a UOP catalytic polymerization unit, a gas recovery plant, a treating plant for gasoline and much auxiliary equipment. Arthur G. McKee & Co. constructed the plant, J. F. Pritchard & Co. provided offsite facilities and Universal Oil Products Co. had charge of the design and engineering.

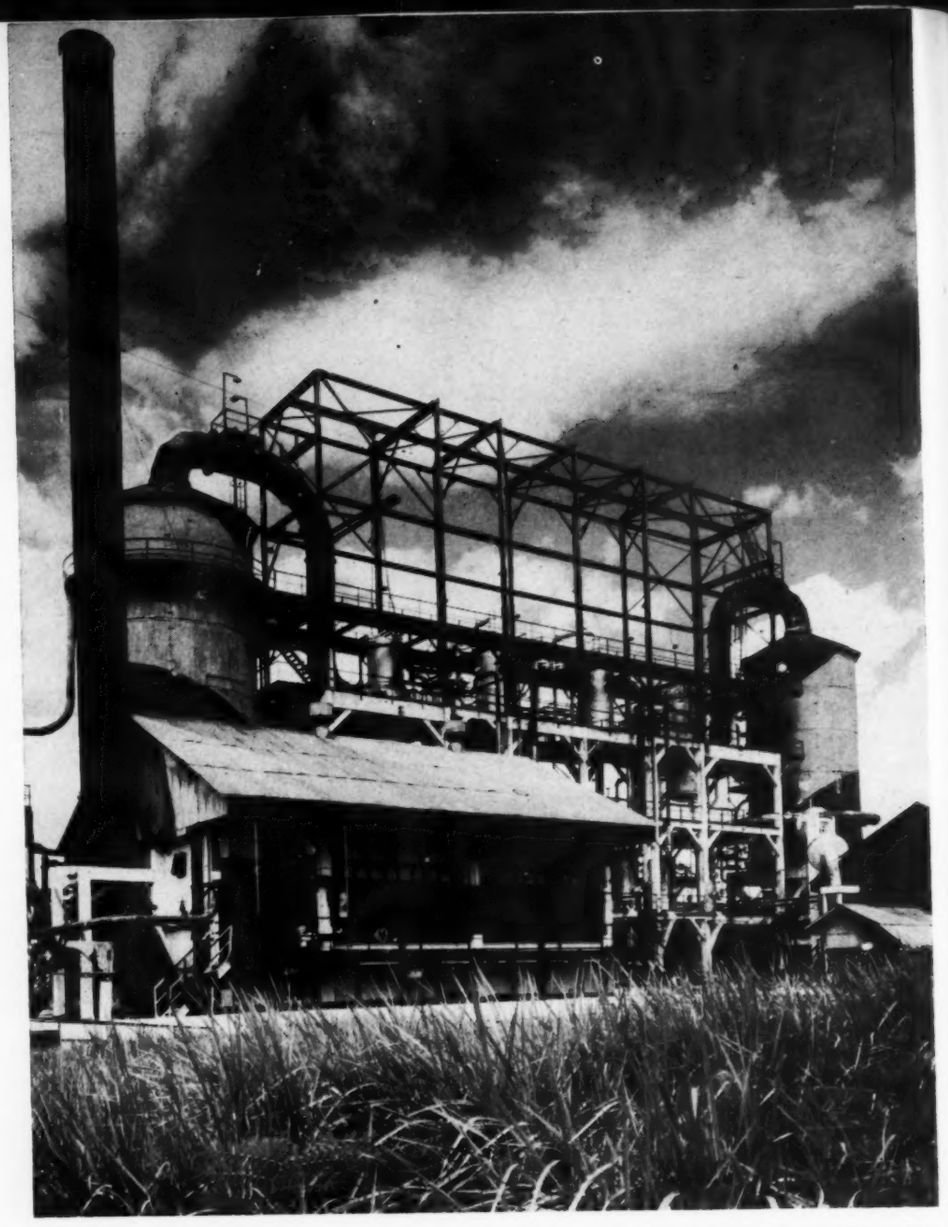
An example of the spread of catalytic cracking to smaller refineries is the installation of a fluid cat cracker by Rock Island Refining Corp. of Indianapolis, Ind. This unit, engineered and licensed by Universal Oil Products Co. will have a daily charging capacity of 5,000 barrels. The refinery's stills and storage capacity are being enlarged to handle a throughput of 10,000 barrels daily.

At Lawrenceville, Ill., The Texas Co. is adding to its plant a crude desalting unit, a vacuum unit designed to handle sour crudes, a fluid catalytic cracker and a catalytic polymerization unit. These additions are expected to be fin-

(Continued on page 100)



Polymerization unit under construction at the East Chicago plant of Sinclair Refining Co. where a major building program has been undertaken.



Rehabilitated vacuum stills at Standard Vacuum Oil Company's Soengi Gerong refinery near Palembang, Sumatra. The plant now is back to prewar capacity of 45,000 barrels daily. Corsini photo.

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WORLD WIDE REFINERY EXPANSION PLANNED

WITH world demand for oil growing in intensity and with recognition of the fact that larger supplies of petroleum products are vital to restoration of the war disturbed economy of many countries in the Eastern Hemisphere the growth of refining capacity, outside the United States during the past twelve months was still less than had been hoped. Engineering plans for many important works had been drawn and accepted but various circumstances have conspired to delay progress. Inability to obtain materials, lack of transportation, shortage of exchange or disturbed internal conditions are some of the causes that have been responsible.

Nevertheless progress has been made. Some of the plants that were put out of operation in the course of the war have been repaired to the extent that they can work to part capacity and some installations of new equipment have been made adding perhaps 300,000 barrels to daily runs. While this is insufficient to meet market needs it is reasonable to assume that the gap will be closed when restraining conditions which are temporary in their nature are removed. It means merely that the task confronting the industry has grown greater and will take longer to complete than was contemplated originally.

One country that has made substantial strides in expanding its refining facilities is Canada. New plants have come into operation, both east and west. At Montreal East the $20 million modernization program at the refinery of Imperial Oil Ltd., started in 1946, is nearly completed. The new crude unit handling 13,200 barrels daily has been in operation since May 15; the light ends unit began working in June. The fluid catalytic cracking installation charging 11,000 barrels per day goes on stream during the current month. The catalytic polymerization plant will be ready later in the year. Offsite facilities of the refinery include additional steam generating units, storage tanks, a 16-million gallon water cooling tower and other acces-

Anglo Iranian Oil Company's refinery at Abadan is now the largest refinery in the world. It currently is processing 500,000 barrels of crude oil daily.

→

sories. With its new equipment the plant will have a daily throughput of 33,000 barrels. It was built from designs of Standard Oil Development Co. by the Canadian Kellogg Co. Ltd.

At Montreal East the British American Oil Co. Ltd., is installing new processing facilities and enlarging the capacity of its refinery from 15,000 to 32,000 barrels daily. A fluid catalytic cracking unit of 13,000 barrels per stream day capacity on a fresh feed basis is being installed along with increased crude running capacity for the production of high octane gasoline. A new catalytic polymerization unit will be erected polymerizing propylene and butylene gases for the production of high octane polymer gasoline. New facilities for the production of liquid propane will be incorporated. All existing process equipment will be revamped and modernized in conjunction with the new installations. Office buildings, laboratory, tank storage and other subsidiary facilities will be enlarged and improved.

Further west, in Alberta, where the discovery last year of the Leduc field has greatly stimulated drilling activity, Imperial Oil Ltd. has established a 6,000 barrel refinery. This plant was moved bodily from its wartime location at Whitehorse, Canada, and re-erected with additions near Edmonton. It was described in a recent issue of this magazine.* It is now in operation as a skimming plant and the combination thermal cracking and reforming unit will begin operation before the end of the year. A pipe line is being laid from the Leduc field to the refinery to replace the temporary method of transporting crude by tank truck.

At Lloydminster on the Alberta-Saskatchewan border Husky Oil and Refining Co. Ltd. is increasing the capacity of its plant from 3,500 to 7,500 barrels daily. Operating on heavy crude it produces fuel oil, asphalt, gasoline and gas oil, products which are much in demand in the western provinces. The Excelsior plant at Lloydminster has been enlarged to 2,000 barrels daily and a new unit is to be installed for the production of light ends, gasoline and diesel oil. A new plant is under construction at Lloydminster by Flintkote Company of Canada Ltd. for the production of a special asphalt road emulsion and other asphaltic products. Construction of a fourth refinery in this area is under consideration by the Saskatchewan Power Commission. If built it will be a topping plant.

On Canada's West Coast near Vancouver, Shell Oil of British Columbia Ltd., recently completed the enlargement of its Shellburn refinery by installation of a $1,500,000 cracking unit, Foster-Wheeler distillation unit, UOP polymerization unit and facilities for redistillization and gasoline sweetening. Further additions are planned which will raise its throughput to 60,000 barrels daily. Standard Oil of British Columbia Ltd. completed recently an asphalt plant in this same locality.

South of the United States Petroleos Mexicanos, government controlled oil company of Mexico, has formulated plans for the expansion of its oil industry both in production and refining. These plans appear now to be in a fair way to realization as a result of a loan negotiated with a prominent United States oil company. Following completion last year of the large Aztacaputzalco refinery decision was made to construct a 25,000-barrel plant at Salamanca in the State of Guanajuato. For later construction a plant at Salina Cruz on the Pacific Coast is contemplated.

Consumption of petroleum products is growing in all South American countries and the rise is particularly rapid in Argentina. Although domestic production increased to 26,867,000 barrels in 1947 it was necessary to import nearly 18,000,000 barrels in order to meet market requirements. The country is becoming motorized to a greater extent than any other on the continent. Importation of motor vehicles in 1947 included over 80,000 units, a majority consisting of trucks and busses. For 1948 the estimated gain in gasoline consumption is over 20 percent and a large increase is certain in fuel oil demand which now constitutes 60 percent of all market requirements.

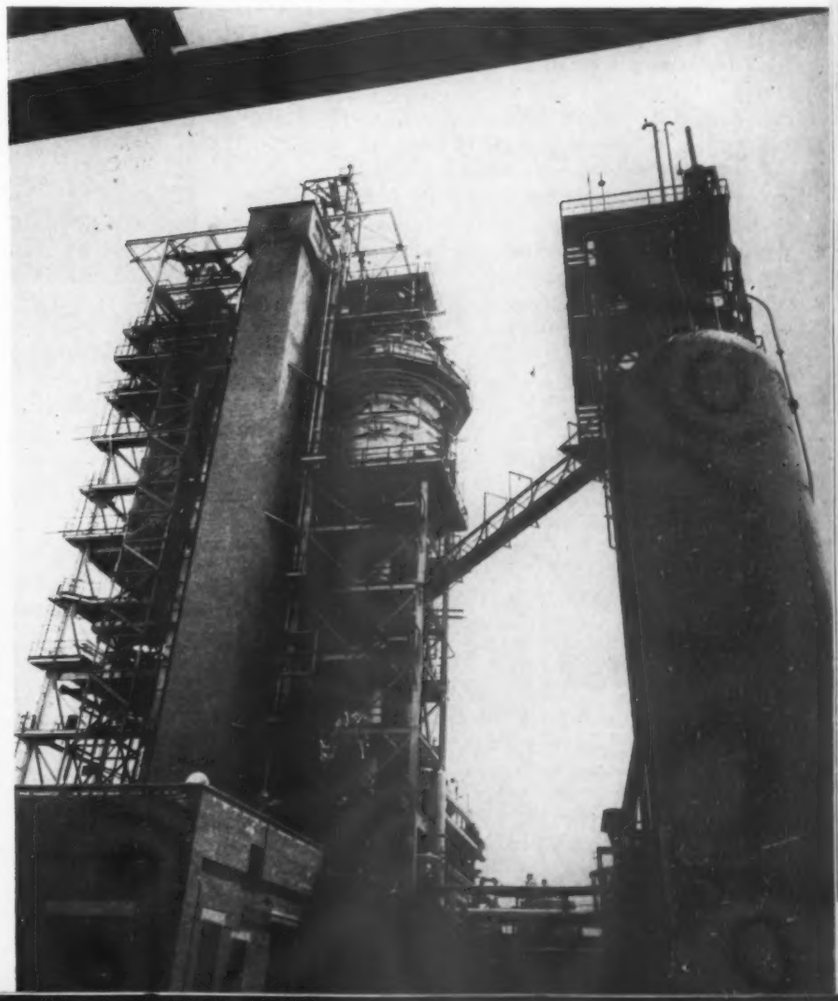
As government policy favors the importation of crude rather than products, extensive plans are in process for the enlargement of refining capacity. Yacimientos Petroleferas Fiscales, the government controlled company, recently signed an agreement with M. W. Kellogg Pan American Company for the erection of a 28,500-barrel refinery near Buenos Aires, a 19,000-barrel combination unit for its San Lorenzo refinery and a 9,500-barrel combination unit for the Mendoza refinery.

The Buenos Aires refinery, to be located some 10 miles from the heart of the city, is designed largely for the production of fuels and paving asphalt. The crude distillation unit will run either on Comodoro Rivadavia or Challaco sour

(Continued on page 104)

* See WORLD PETROLEUM, May 1948

Imperial's new 11,000-barrel fluid cat cracker at Montreal, Canada, built as part of a $20 million modernization program. →



Edmonton, Alberta, refinery of Imperial Oil Ltd., which began operations on July 16. The plant was dismantled and shipped by rail from Whitehorse, Alaska.

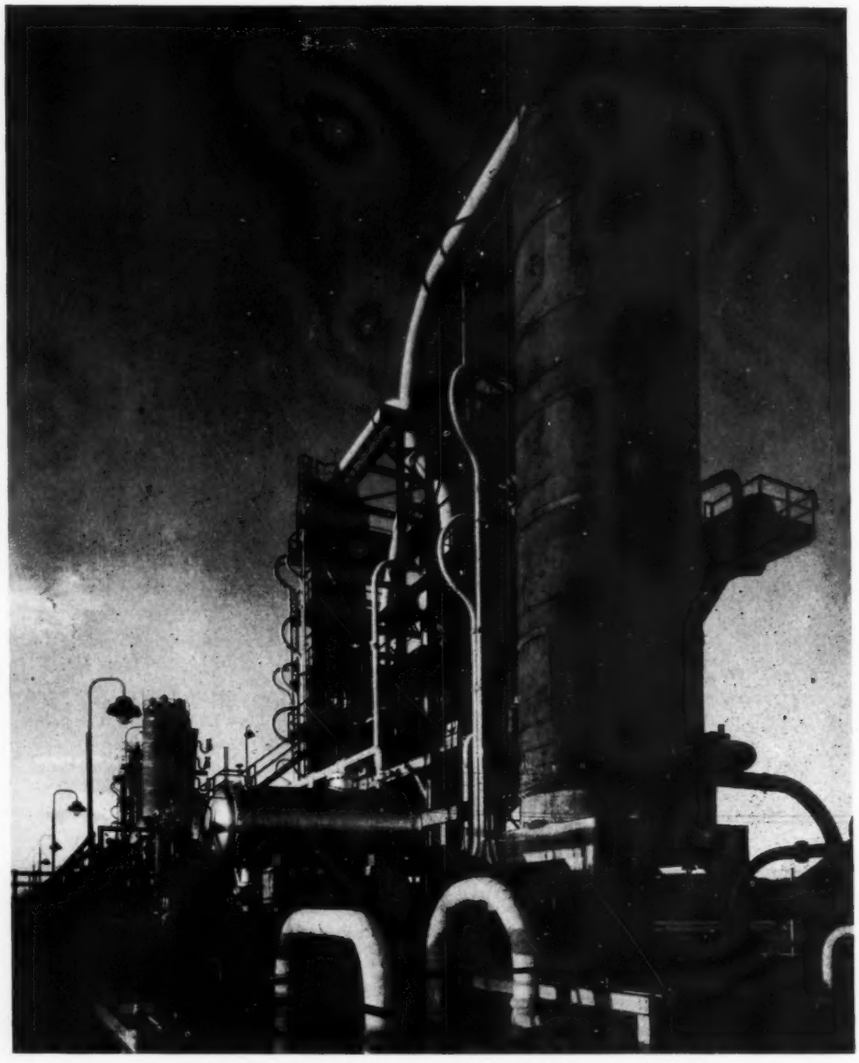
FRANCE MAKES PROGRESS IN REFINERY RECONSTRUCTION

By H. BALLANDE

AT the time of French liberation from Nazi domination in September 1944, the daily capacity of the few refineries capable of operation had been reduced to 30,000 barrels per day. This was less than 20 percent of the 156,000-barrel daily capacity existing in 1938. A majority of the country's refining establishments, including the larger ones, were within the various battle zones, and these had suffered varying degrees of damage ranging up to complete demolition of the plant at Dunkerque and could not be brought back quickly into service. First attention, therefore, was given to the refineries in the south which had suffered less severely but had been out of action since 1940 and needed complete overhauling and many replacements. By the end of 1945 it had been possible to add only about 10,000 barrels per day to the minimum reached in the final year of the war.

Under the program laid down for establishment of the industry, known as the Monnet plan, it was proposed to return capacity to the prewar level by the end of 1948. Actually, in spite of many difficulties in obtaining materials and equipment, that goal already has been surpassed. By the end of 1946 capacity had risen to 90,000 barrels daily; by midyear 1947 it was up to 110,000, and on June 1, 1948 it had reached 177,750 barrels as compared with 156,000 at the commencement of the war.

As of June 1 eleven refineries were in operation capable of processing 8,715,000 tons of crude annually. According to the plan which contemplates a gradual increase in facilities up to 1952, the facilities of some of these refineries will be expanded and other plants will be brought into operation to provide by July 1, 1952 a yearly capacity of 16,940,000 metric tons, or a daily throughput of 348,050 barrels. The schedule set up for realizing this objective with the daily capacity of each refinery is shown in the accompanying tabulation.



Crude distillation at Port Jerome refinery of Standard Francaise de Petroles.

Effect of the war upon the various refineries, the extent of their rehabilitation up to the present and projected enlargements will be described.

Cie. Francaise de Raffinage, in which the French government has a major interest, owned two refineries before the war, one in Normandy near Le Havre with a processing capacity of 35,000 barrels daily, and the other of 20,000 barrels in Provence near Marseilles. The plants were built in the early thirties to process the French share of crude produced by the Iraq Petroleum Company. The northern plant was occupied by the Germans in 1940, after the storage facilities had been fired on orders from French military authorities. Most of the usable equipment was dismantled and sent to Germany, and on withdrawal of the Nazi forces, the power plant was blown up. Some 20,000 tons of equipment were removed or destroyed.

By July 1946 rehabilitation of the plant, largely through repair of less damaged parts, enabled it to resume operation, processing 14,000 barrels daily, and by the end of 1947 the daily run had been increased to 26,000 barrels. The refinery in Provence had been in operation since 1945 and at the beginning of the present year, the com-

PROGRAM OF REFINERY DEVELOPMENT

Company	Refinery	June 1-48	July 1-50	July 1-52
Shell Group	Petit-Couronne	26,000	26,000	28,400
	Pauillac	3,100	3,100	3,100
	Berre	16 500	43.600	47.800
Standard Francaise des Petroles	Port-Jerome	30,700	40,000	50,000
Compagnie Francaise de Raffinage	Gonfreville	32,000	43,400	62.000
	La Mede	30,000	39,000	62,000
Soc. Generale des Huiles de Petrole	L'Avera	18,500	20,700	20,700
	Dunkerque	—	6,200	22,700
Raffineries de la Vacuum Oil Co.	Gravenchon	11,100	7,400	7,400
Compagnie Industrielle des Petroles	Frontignan	1,350	12,400	12,400
Raffineries Francaise de Petrole de L'Atlantique	Donges	7,400	12,400	16,500
Raffineries de Petroles de la Gironde	Bec d'Ambes	—	12,400	13,600
Pechelbronn	Merkwiller	1,100	1,450	1,450
	Totals	177,750	268,050	348,050

bined capacity of the two plants had reached 60,000 barrels daily.

Further additions to capacity are to be provided by the installation of distillation units by the end of 1949 and of a lubricating oil plant during 1950. As larger quantities of crude become available through increased production in Iraq, further additions to refining facilities are projected which will bring the daily capacity of each of the two plants up to 62,000 barrels by 1952.

Most modern and complete of French refineries as well as foremost in size prewar was the Port Jerome plant of Standard Francaise des Petroles, an affiliate of Standard Oil Company (N. J.), Gulf Oil Corporation and Atlantic Refining Co. Some of the key facilities of the plant were destroyed by order of French military authorities at the time of the Nazi invasion. Later a large part of the processing equipment was removed to Germany. Following the withdrawal of the invading forces, operations were resumed on a small scale in the production of fuel oil and asphalt. At the present time the refinery is capable of handling about 30,000 barrels daily, operating merely as a topping plant. Installation of a 30,000-barrel atmospheric still is expected to double topping capacity within the next year, and delivery of other specialized equipment is counted upon to make possible the production of a full line of products by 1952.

Refineries of the Shell Group included plants at Petit-Couronne near Rouen on the Seine, Pauillac in the Bordeaux district, and at Berre near Marseilles. At the first of these the tankage was destroyed in face of the German invasion, and the equipment was looted by the Nazis after they gained possession. Pauillac was almost completely destroyed by bombing in 1944. Only Berre escaped serious damage, and it was able to resume operation late in 1945 with daily runs of about 16,000 barrels. Temporary repairs at Petit-Couronne enabled it to start working in 1946 with runs of 4,500 barrels per day, which gradually increased to 27,800 barrels at the commencement of 1948. Pauillac is now operating primarily as an asphalt plant handling 3,100 barrels daily.

Company plans for reconstruction provide for a gradual increase in throughput at Berre rising to 47,000 barrels daily in 1951. Petit-Couronne will be maintained at about its present capacity, but facilities for the production of liquefied petroleum gas and lubricating oil will be added.

Before the war Soc. Generale des Huiles de Petrole, an affiliate of Anglo-Iranian Oil Co., Ltd., operated two refineries, one at L'Avera, just outside Marseilles, and the second at Courchelettes in the north, which received its supplies through the port of Dunkerque. Avera passed through the war practically undamaged and was able to resume operation after liberation as soon as supplies of crude could be obtained. Daily throughput has been gradually increased from 12,000 to 18,500 barrels, and installations now in progress and to be completed in 1949 will raise capacity to 20,700 barrels and will make possible the production of higher-grade gasoline stocks.

Courchelettes on the other hand, being in the zone of intense fighting in the early period of the war, was left in a state that required complete reconstruction. The nearby Petrole du Nord refinery in Dunkerque was almost totally obliterated, and the few pieces of usable equipment remaining were carried off by the Germans. The two refineries had previously competed for business in the same area, and after the war SGHP acquired the site of Dunkerque and decided to erect a new refinery there with an ultimate capacity of 22,700 barrels daily, operating it in conjunction with Courchelettes, which would be restored as a lubricating oil plant. Construction at Dunkerque has begun, and the plant, which is being engineered by The Lummus Company, is expected to open in 1950 with an initial run of 6,700 barrels daily. Work at Courchelettes was started this year and is scheduled for completion in 1951.

At Notre Dame de Gravenchon in the Seine district is the plant of Raffineries de la Vacuum Oil Co. S.A.F. and at Frontignan in the south is the Compagnie Industrielle des Petroles. Both of these are affiliates of Socony-Vacuum Oil Company. All principal equipment at Gravenchon, filling 900 cars, was shipped to Germany, and destruction of the plant was completed by bombing during the Allied attacks of 1944.

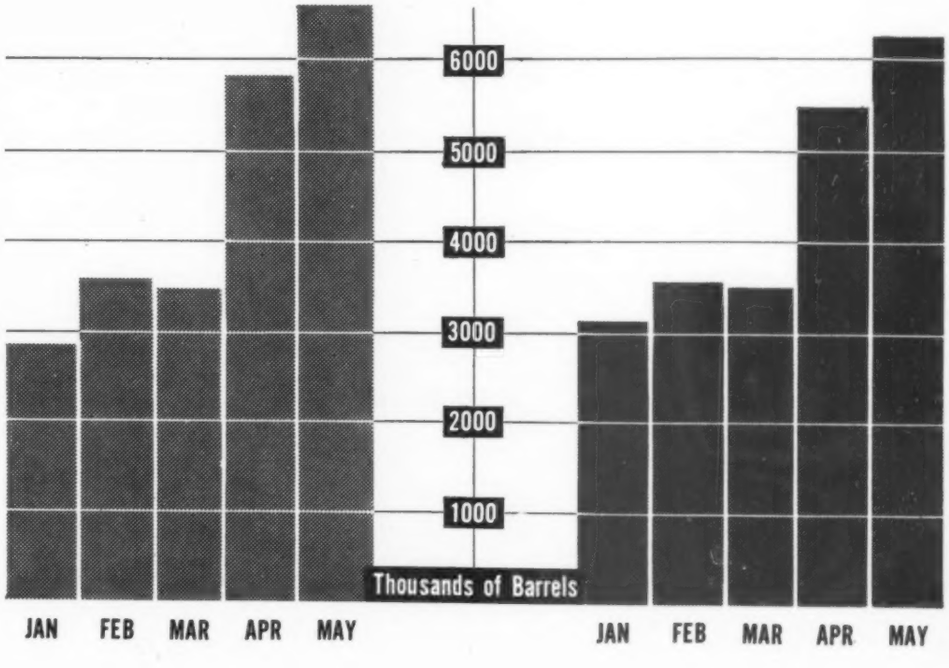
Reconstruction of the plant is proceeding partly with recovered equipment and includes a vacuum distillation unit, a solvent processing plant, dewaxing and rerun units. Other units are on order. Frontignan was badly damaged during bombing attacks that preceded the landing of Allied troops on the Mediterranean coast but was able to continue the production of lubricating oils, being the only plant in France in a position to do this. Crude processing is being resumed this year along with the production of lube oils at the rate of 3,200 barrels daily. A new distillation unit is being added, and production is expected to reach 12,400 barrels daily in 1949.

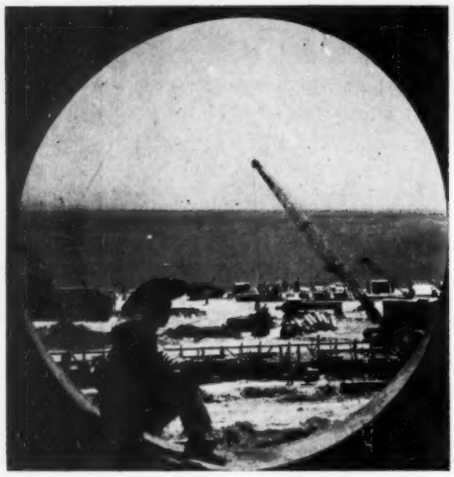
Raffinerie de Petrole de la Gironde at Bec d'Ambes in the Bordeaux district had a daily capacity of 6,200 barrels before the war. It was badly damaged by bombing attacks in 1944 and was closed down for some time. It was acquired by California Texas Oil Company when the latter took over the European marketing facilities of The Texas Company, and in 1947 the construction of a new refinery was authorized, and work on the site is now in progress. New installations include a catalytic cracking plant which will raise daily throughput to 14,500 barrels and which will be available in 1950.

Two refineries located near each other on the north bank of the Loire near St. Nazaire are being merged under the name, Raffineries Francaises de Petrole d'Atlantique. The refineries, which had a daily capacity of 7,000 barrels, were so badly damaged in bombing attacks that they were practically useless. One plant resumed operation in 1947, and the second started up in February of this year. The program for future expansion contemplates a daily production of 11,000 barrels in 1949, rising to 17,000 in 1952.

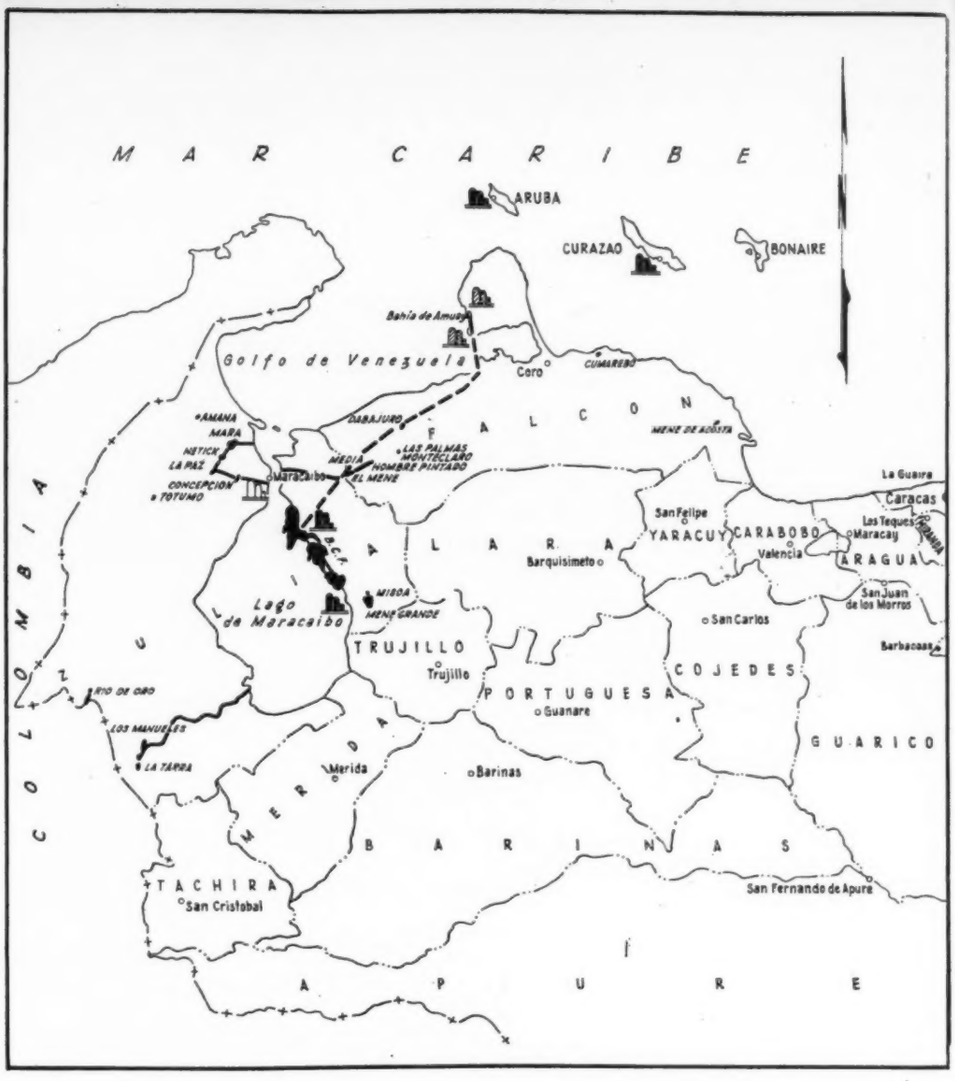
The one remaining refinery in France is Merkwiller, which is the property of Pechelbronn SAEM and handles the crude output of the wells and shafts of that company. It was seized by the Germans when they invaded France, but was restored to its owner following liberation, and production during 1949 is expected to reach 1,550 barrels daily, which is about the normal output of the Pechelbronn wells.

Chart showing activity of French refineries by months from January through May of 1948. Refinery receipts of crude are shown in columns at the left and throughput of stills in columns at the right. Great progress has been made in increasing runs since the close of the first quarter.





VENEZUELA EXPANDS REFINING CAPACITY



Amuay Bay refinery project. Punta Judibana Dock and office area, with 150,000 bbl. storage tank in left foreground.

IN connection with the acquisition of concessions at various times during the past few years, oil companies operating in Venezuela agreed with the government to construct refineries with capacities based principally on the amount of production obtained. This, together with the world's unprecedented demand for oil products, accounts for the unusual activity that is taking place in refinery construction at the present time. As indicated on the chart four foreign companies in Venezuela have at present a combined refining capacity of 133,000 barrels daily. These are Creole Petroleum Corporation, a Standard affiliate, with 82,000 barrels daily; Caribbean Petroleum Company, a Shell subsidiary, with 37,000 barrels daily; Mene Grande Oil Company, a Gulf Oil subsidiary, with 4,000 barrels daily; and Texas Petroleum Company with 10,000 barrels daily. To this present operating capacity will be added approximately 190,000 barrels per day when four projects under construction and one on the agenda are completed. This increase, bringing the total up to 323,000 barrels daily, will more than double present refining capacity.

Refineries under active construction are those of Shell Company of Venezuela at Punta Cardón and Creole Petroleum Corporation at Amuay Bay, both on the Paraguaná Peninsula. Two others, in preliminary stages of construction, are those of Compañía Consolidada de Petroleo and the Mene Grande Oil Company (operating under the name of Venezuela Gulf Refining Com-

Pipeline storage area at Amuay Bay Refinery.

pany), both at Puerto La Cruz. The fifth project is that of Richmond Exploration Company, a Standard of California subsidiary, which signed a contract with the Venezuelan government late in May to construct a 25,000-barrel-a-day refinery south of Maracaibo.

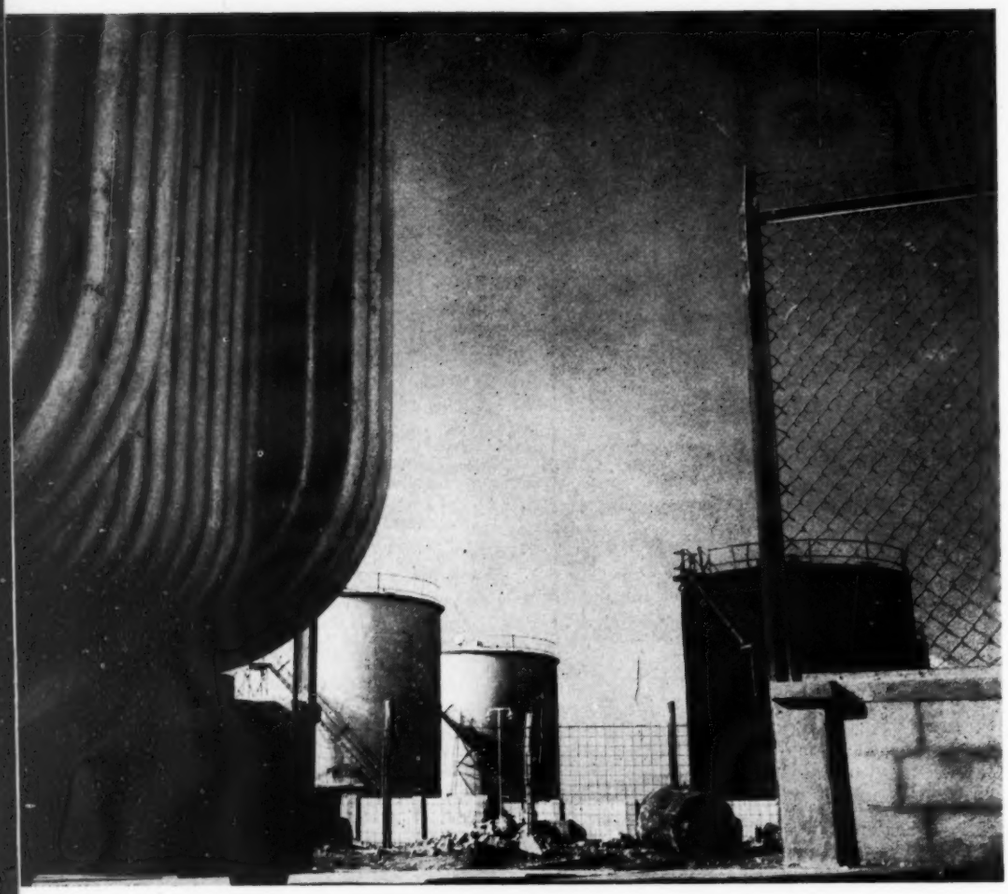
Existing refineries provide for the country all it needs of oil products, except lube oils, aviation gasoline and specialty products. The new projects will provide a sizable export trade in refined oil products and will strengthen the country's position as the world's greatest oil-exporting nation.

With construction costs constantly rising, it is impossible to know what capital investment these new projects represent, but it certainly will be in excess of $350,000,000.

Creole Petroleum Corporation's project at Amuay Bay, on the western side of Paraguaná Peninsula about 150 miles northeast of the Lake Maracaibo oil fields, is now estimated in excess of $120,000,000, or considerably more than the original estimate. One reason for this discrepancy in cost estimates was the decision to increase the refining capacity from 40,000 to 60,000 barrels per day. Material shortages and consequent delays, together with steadily mounting costs, are other constributing factors.

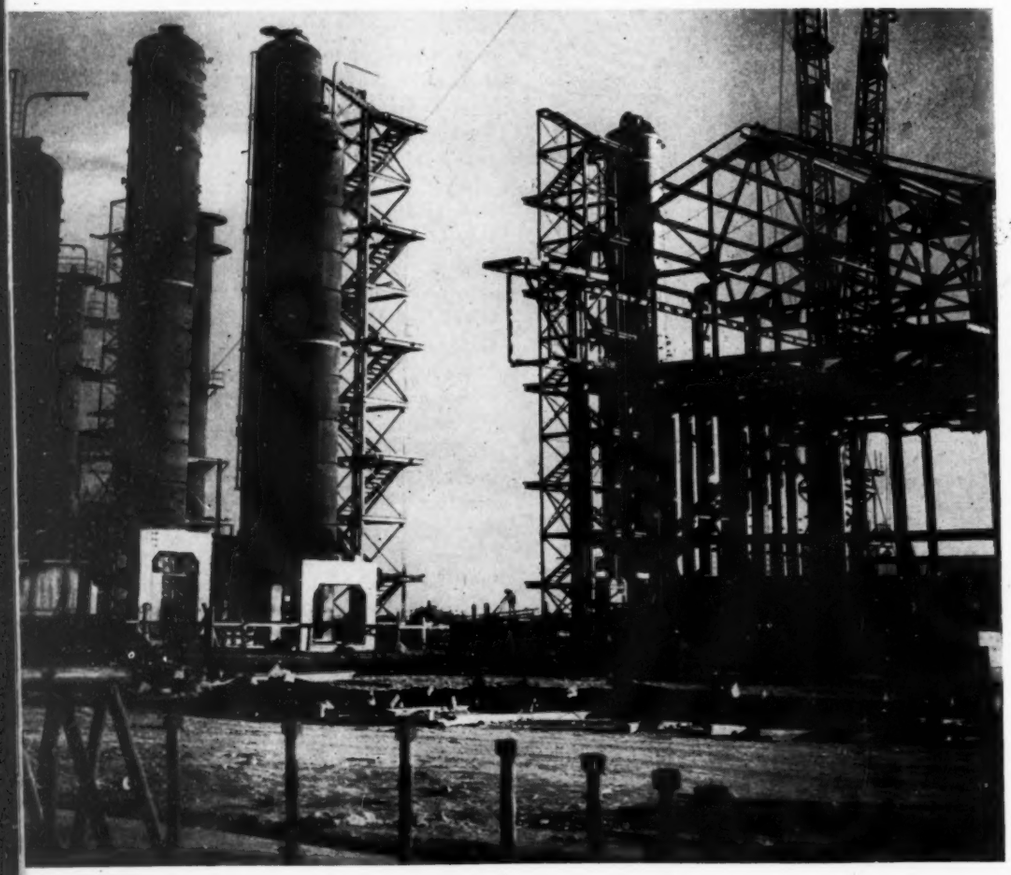
At Amuay, bordering the bay, Creole has a property of 4,500 acres which it is grooming to accommodate a complete and modern community with housing and other facilities for 10,000 persons, in addition to the refinery plant itself. The terrain is relatively flat, very dry and barren. Annual rainfall averages less than 13 inches, and five-to-thirty-miles per hour winds blow almost continuously.

Preliminary work started in October 1946, when surveys were initiated and a temporary beachhead was made. Horace Williams, of New Orleans, constructed a wooden barge dock to receive freight from shallow-draft vessels; Gahagam Construction Company dredged some 5,000,000 cubic yards of soil to improve the harbor and make possible the entry of ocean-going craft to the large material dock with oil-handling facilities now in operation, and to the two oil-handling finger piers now under construction. These are of steel and reinforced concrete and will accommodate six ocean-going tankers. The main dock has an approach trestle 1100 feet long, also of reinforced concrete and steel. Sizable warehouses have been built, a number of storage tanks have been erected and a network of good roads has been constructed. Temporary power facilities have been built to furnish electricity during plant construction, until the permanent power house is erected. Potable water is imported by tanker, with standby evaporation plants used to derive fresh water from sea-water when necessary. By 1951 Creole Petroleum Corporation and Shell Company of



↑ Transformer station No. 11 under construction at Punta Cardon refinery project.

↓ Group of columns with heater of cracking unit No. 1 being erected at Punta Cardon.



Venezuela will have a joint 34-inch gravity-flow water line from Siburua in the San Luis mountains southeast of Coro, State of Falcón, a distance of some 67 miles from Amuay. Creole's plans provide for three 150,000-barrel tanks for water storage.

The housing project, designed by Skidmore, Owings and Merrill, provides for some 2,000 permanent homes and all municipal facilities such as a recreation center, a community theater, clubs, schools, stores, restaurants, laundries, a dry-cleaning plant, a hospital, gas stations, sewage disposal, fire stations, two churches, army barracks, a police station, an incinerator and a cemetery.

All homes, whether for general workers, junior staff or senior staff, have been planned carefully with the occupants' comfort in mind. Never has the Venezuelan worker, for instance, enjoyed such living quarters. A shaded porch and garden patio give it privacy; perforated patio walls, metal window blinds and fixed louvers are responsible for cross ventilation; storage space is ample, and the rooms are truly spacious. With trees grouped to form windbreaks and with green lawns and flowering shrubs roundabout, beauty has been substituted for bleakness. Fortunately, the top soil, composed mainly of silt, sand and clay, is of high fertility and, therefore, has possibilities under irrigation. Plants native to the place such as prickly pear, organ cactus, mesquite and trees of the olive, caper and locust families will improve in size and appearance with a regular supply of moisture, while others such as Australian pine and many varieties of palm will adapt themselves.

The refinery itself, when completed, will consist of an atmospheric pipe still, a naphtha fractionator, a hydroformer, a hydroformer stabilizer, a rerun still, a lube oil plant and gas compressors and pumping facilities. The lube oil plant will have a vacuum pipe still, a phenol extracting unit, a dewaxing unit and a clay-contacting unit. Tanks of varying capacities, including 33 tanks of 150,000 barrels each, are being installed in connection with the refinery and crude terminal facilities. W. J. Connelly, in charge of Creole's refinery activities, hopes to have the refinery ready for operation by July 1950. It is estimated that over 6,000 men will be employed during construction at its peak, and that 2500 men will be required to operate the plant. Crude oil for both plant and terminal will be brought from the Maracaibo oil fields through the new 24- and 26-inch Ule-Amuay pipeline, a $30,000,000 project being built to ease the lake tanker situation and now approaching completion.

Not less ambitious is the complete and ultra-modern 50,000 barrel refinery of Shell Company of Venezuela, Ltd., located at Punta Cardón on the southwestern corner of Paraguaná Peninsula. It is, in fact, the only new plant on which very substantial progress has been made. With the refinery site on deep, sheltered water, dredging for anchorage has not been necessary, but all the other obstacles present at Amuay had to be overcome. Here too the problem has been to

carve a carefully-planned modern community and to house upward of 10,000 people and provide them with all facilities for comfortable living, out of a desolate, cactus-covered waste, and to erect all the necessary buildings and installations required of the industry.

Preliminary construction began in May 1945, and is now so well advanced that the first refinery units are expected to commence operating before the end of this year, or one and one-half years ahead of obligation.

The site for refinery and colony comprises over 3300 acres. Already completed or under construction are a church, commissary, market and shops, three clubs, post office, bank, pharmacy, modern 100-bed hospital and clinic, beauty shop, laundry, incinerator, restaurant, three large schools, police barracks, open-air cinema with seating capacity for 1200, baseball and football fields, cricket pitch and a nine-hole golf course. Many permanent houses already have been built. An attractive Plaza Bolívar, typical of all Venezuelan towns, is the colony's civic center.

The refinery contains the following processing equipment:

1—Two-stage (atmospheric and vacuum) crude distillation unit
2—UOP termal cracking units
1—UOP thermal reformer
1—High-vacuum distillation unit
1—Pressure distillate redistillation unit
1—Gastail (cracked products separation)
1—Catalytic polymerization unit
1—Alkylation plant (sulfuric acid process)
1—Ethyl blending plant
1—Lube oil plant

With these are the usual auxiliary processing and treating units. Very large steam and electric power plants, salt water pumphouse and other accessory facilities are now nearing completion; offices and laboratories have been built; tank farms for crude oil and intermediate and finished products, extensive workshops, stores and so on have already been completed and are in use. Most of the plant equipment has come from England. The crude oil will be brought from the Maracaibo Basin oil fields in large tankers of shallow draft.

Two magnificent, ultra-modern, deep-water jetties, each approximately 450 meters long, have been completed. Each will provide two berths for lake tankers and two for deep-draft, ocean-going vessels.

With construction now at its peak stage, about 6,000 Venezuelans and 670 foreigners are being employed. The total cost of the project is not known but is estimated to exceed $130,000,000. C. P. Louwerse is in charge of construction at Cardón.

With an eye toward meeting their obligations to operate by December 31, 1950, the Venezuela Gulf Refining Company and the Compania Consolidada de Petroleo are constructing temporary warehouses and permanent dwellings near their respective terminals at Puerto La Cruz. Here are no special problems peculiar to the site as in Paraguaná, and the work is going ahead as rapidly as availability of materials permits. The harbor, protected by a narrow peninsula partly enclosing it, is excellent. It is coral-bottomed and has 44 feet of water, thus accommodating ocean-going vessels. The companies' respective docks, built for their terminals, will serve for the refineries too. Both companies will furnish their own utilities. Water will be brought from the Néveri river or from wells through a 16-inch pipe.

Company	Refinery	B/D Capacity	New Project	B/D Capacity	B/D Total
Creole Petroleum Corp.	La Salina	12,000	Amuay Bay	60,000	142,000
	Caripito	70,000			
Shell Co. of Venezuela	San Lorenzo	37,000	Punta Cardón	50,000	87,000
Mene Grande Oil Company	Cabimas*	2,000	Puerto La Cruz	20,000	24,000
	Oficina*	2,000			
Texas Petroleum Company	Tucupita*	10,000	—	—	10,000
Comp. Consolidada de Petroleo	—	—	Puerto La Cruz	35,000	35,000
Richmond Exploration Company	—	—	Maracaibo	25,000	25,000
Totals		133,000		190,000	323,000

*Topping plants

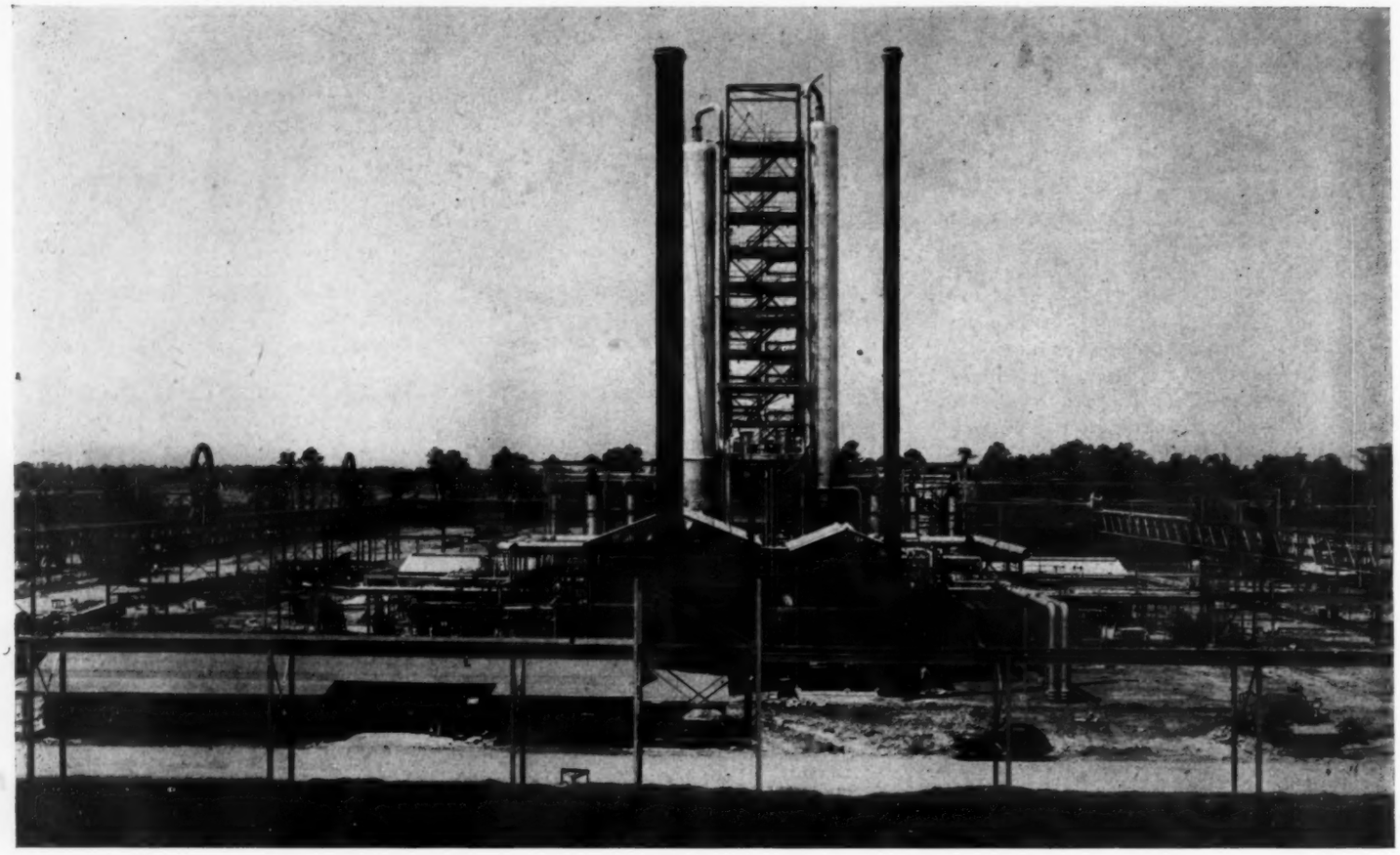
The Venezuela Gulf Refining Company has a 330-hectare (815-acre) site for its housing program of approximately 260 units. The refinery, which will have a charging capacity probably in excess of 20,000 barrels, will have an atmospheric topping plant and a polyform unit. Its products will be gasoline, diesel oil, furnace oil and residual fuel oil. The tank farm will have an undetermined number of tanks with a maximum capacity of 80,000 barrels each. Being installed is a 150-ton stiff-leg derrick for removing heavy freight. Some 1500 men, most of them nationals, will be employed on the general project. Luther Jones is in charge of refining activities.

Compania Consolidada de Petroleo contracted to build a 35,000-barrel refinery plant, and preliminary work was under way by midyear of 1941. It has constructed a loading dock, eight 80,000-barrel tanks, a water system, shops and some 20 permanent houses, which, while used in the company's terminal, will be incorporated in the refinery lay-out.

Venezuelan Atlantic Refining Company, Phillips Venezuelan Oil Co., S.A., Petrolera Las Mercedes and Caracas Petroleum S.A. have the obligation to construct refineries if and when their 1944 concessions yield sufficient crude to warrant such enterprise.

With completion of these undertakings, Venezuela, already firmly established as the leading exporter of oil, will take rank among the principal processors of crude and will strengthen its domestic economy and will be in a position to adapt its exports to market requirements.

Temporary staff construction camp (bachelor quarters).



THE FUTURE OF LUBRICATING OILS

By E. R. Smoley
The Lummus Company, New York

THE refiner, when he looks into the future of lubricating oils, is interested in what quantities he must produce as well as what quality changes he must anticipate. Today premium lube oil blending stocks are solvent refined and dewaxed to as high as 95-100 viscosity index and zero °F. or lower pour point. Additives are blended with these stocks for imparting additional qualities. Synthetic organic lube oils were introduced during World War II.

Mineral oils from petroleum have been used successfully for lubricating machinery from as far back as the beginning of the Christian era. They were originally the crude oil and later the distilled raw lube stocks. This was followed by acid treating, wax settling and other processes developed by the refining industry for refining lube oils. Solvent refining and dewaxing were introduced commercially less than twenty years ago and made possible the production of 85 V.I. or better oils with 0° to 20°F. pour point from practically any crude source. The use of raw stocks from less desirable crudes has been increasing of necessity, and the replacement of plants producing lower quality lubes by modern solvent refining installations still continues. It is believed that the lubricating oil blending stocks produced by these modern methods will require no major improvement in quality to satisfy future premium lube oil requirements.

The improvement in the quality of lube oils by the use of additives in these refined lube stocks has represented a real development in this field. They reduce wearing of metals, formation of laquer and varnish deposits, sludging, oxidation, etc., increase oiliness, viscosity index and reduce pour point. Considerable research is still being carried out in this field and it is expected that further developments and improvements will result in the future use of additives. No major change, however, in the present manufacture of premium lubes, i.e. the use of a fractional percent of additives to refined lube blending stocks, is anticipated.

Synthetic organic lube oils were produced and used during the last war and have demonstrated some very special qualities, such as extremely high viscosity index and very low pour points. These oils are very expensive and it seems fairly certain that their use will be limited to special applications such as for fine sensitive machines, and for airplane engines exposed to very low temperatures.

It is, therefore, fairly evident that the present modern refining equipment will continue to supply the future quality demands for lube oils and that any predictions of production and consumption quantities based on present solvent refining and dewaxing plants will represent a true future picture.

The petroleum refining industry has been struggling with its program of construction of modern lubricating oil plant facilities in an attempt to make up the time lost during the war when such construction was neglected. More plants have been planned and are now under construction since those outlined about a year ago,[1] but

Vacuum distillation unit for the preparation of raw lubricating oil stocks at Shell Oil Company's Houston, Texas, refinery.
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the great difficulty of obtaining steel for construction of refining facilities continues to delay this construction program appreciably and will extend the catching-up period.

Modern lubricating oil manufacturing facilities are not as simple as in the old days but they give increased yields of higher quality products. A typical plant for processing reduced crude for full production of premium grade lubes, 95 V.I. and zero pour, includes a vacuum distillation unit, propane deasphalting plant, single solvent refining unit, solvent dewaxing plant and a clay finishing unit. The higher the quality of the lube oil produced, that is the higher the viscosity index and the lower the pour point, the lower the yield of finished lube oils obtained. Projected production figures, therefore, on the basis of new plants being installed will be lower if yet higher quality oils are demanded. It is also difficult to estimate from new lube facilities the quantity which replaces lubes already being manufactured of lower quality and the amount which represents new lube oils. The following tables, however, are a good indication of increased lube oil production from plants now under construction both in the United States and outside this country.

Table 1 shows the 11 existing propane deasphalting plants and the 13 plants now under construction with a total charge capacity of approximately 74,000 B/D. The propane-to-oil ratio averages about eight to one. If we assume an average yield of 40 percent deasphalted oil, the production of heavy raw lube stock amounts to 29,600 B/D. The tables give for each plant the company, location and estimated average daily charge oil capacity.

Table I

Propane Deasphalting Plants

Refinery	Location	Est. Chg. Cap. B/D
Union Oil Co. of Calif.	Oleum	2,000
Shell Oil Co.	Wood River, Ill.	3,300
The Texas Co.	Port Arthur, Texas	1,900
Standard Oil Co. (Ind.)	Whiting, Indiana	1,200
Kendall Refining Co.	Bradford, Pa.	900
Humble Oil & Refining Co.	Baytown, Texas	4,800
Bradford Penn. Refining Co.	Warren, Pa.	250
Esso Standard Oil Co.	Baton Rouge, La.	2,100
Sinclair Refining Co.	Houston, Texas	3,500
Mid-Continent Petroleum Corp.	Tulsa, Okla.	2,000
Atlantic Refining Co.	Philadelphia, Pa.	4,000
*The Pure Oil Co.	Smiths Bluff, Texas	4,200
*Sinclair Refining Co.	E. Chicago, Indiana	5,100
*Shell Oil Co.	Houston, Texas	6,000
*Phillips Petroleum Co.	Kansas City, Mo.	2,000
*Tide Water Associated Oil Co.	Bayonne, N. J.	4,000
*Standard Oil Co. (Ind.)	Whiting, Indiana	3,000
*Creole Petroleum Corp.	Venezuela	2,000
*Shell Oil Co.	Cardon, Venezuela	3,500
*Consolidated Refineries, Ltd.	Haifa, Palestine	7,000
*Anglo Iranian Oil Co.	Llandarcy, S. Wales	2,000
*Comp. Espanola de Petroleo S.A.	Tenerife, Canary Is.	700
*Standard Oil Co. of Ohio	Toledo, Ohio	2,500
	Total	68,010

*Under construction

Table 2 lists the 18 operating furfural refining units, and the 15 units now under construction with a total charge oil capacity of 101,160 B/D. At an average of three to one furfural to oil ratio, the furfural circulated would be over 300,000 B/D. If we assume an average yield of 75 percent raffinate, the average waxy refined lube stocks would amount to 76,000 B/D. This table lists for each plant the company, location and average daily oil charge capacity. Table 2 also lists the 11 operating phenol extraction plants and the 7 now under construction with a total charge capacity of 64,850 B/D. The company, location and daily oil charge capacity for each plant are also given in this table. The other solvent extraction plants now operating and under construction are also listed under DuoSol, SO_2-Benzol, Chlorex and Nitrobenzene Processes with similar information as given under furfural and phenol. The overall total daily oil charge capacity to all solvent refining units is 225,160 B/D and a 75 percent yield would net 169,000 B/D of waxy solvent refined lube stocks.

A more significant indication of finished lube oils is the output from solvent dewaxing plants, as this is normally the final processing step other than clay finishing. The final clay finishing gives an average yield of 95-98 percent. Table 3, therefore, is the most significant indication of finished lube production. This table lists the 29 operating solvent (Ketone-Benzol) dewaxing plants and the 26 units now under construction with an average daily charge oil capacity of about 150,000 B/D. With an average pressed oil yield of 80 percent, the finished solvent refined, solvent dewaxed oil production from MEK units would be 120,000 B/D. Similarly, the dewaxing plants now operating and under construction using Propane, SO_2-Benzol and Barisol are listed in this table, and for all processes the company, location and daily average oil charge capacity are given. The overall total daily oil charge capacity to all dewaxing units is about 175,300 B/D, and at 80 percent average yield the output would be about 140,000 B/D.

To finished solvent refined, dewaxed, clay contacted lubes must be added inhibitors and additives which are used to improve the quality of lube oils by eliminating corrosion, lacquer and varnish formation, sludging, offering resistance to oxidation, adding oiliness, permitting use of pressure between metal parts, increasing viscosity index, reducing pour, etc. The loss of yield, therefore, in clay finishing is approximately compensated by the addition of inhibitors and additives for obtaining total finished lube oil production.

Total lube production in the United States by years including from 1938 to 1947 excluding 1939 based on Bureau of Mines figures[2] follow:

U. S. Lube Production

Year	B/D	Year	B/D	Year	B/D
1938	84,500	1942	108,900	1945	118,300
1940	103,400	1943	109,500	1946	128,900
1941	111,500	1944	115,800	1947	146,000

The figures showing production capacity available built up for 1948 through 1951 based on new lube plants under construction in the United States, with the full realization that increased quality demands would reduce these figures and also that replacement lubes and new lubes from plants now under construction are difficult to estimate accurately, are given here:

Estimated U. S. Lube Production Capacity Available

	1948	1949	1950	1951
B/D Lubes	155,000	173,000	185,000	195,000

The estimates for lube production outside the United States are more difficult. Bureau of Mines[3] supplies 1938 and 1946 lube production for all countries outside the United States as follows:

Lube Production Outside U. S., B/D

	1938	1946	1947	1948	1949	1950	1951
N. W. I.	6,000	3,800					
South America	1,300	300					
France	4,400	1,000					
Germany	3,000	1,100					
Italy	1,700	—					
Roumania	1,300	2,000					
United Kingdom	2,800	6,400					
U. S. S. R.	27,000	21,000					
Burmah	300	—					
Japan	6,000	800					
Others	4,700	5,700					
Total Outside U. S.	59,100	42,100	42,000	42,000	46,000	50,000	60,000
Total Incl. U. S.	143,600	167,100	188,000	197,000	219,000	235,000	255,000

Estimates are made in this table for total production capacity available for the years 1947-1951 inclusive. Since U.S.S.R. figures are quite uncertain, the above estimates assume about 25,000 B/D for each of these years. There is probably no doubt that they will rebuild and expand some of the plants which were built prior to the war and the above figures are probably low. The rest of the production available capacity increase estimates are based on new lube plant capacity now under construction or being projected outside the United States. The world total estimated lube available production figures including the United States total 255,000 B/D for 1951. These estimates are all dependent on a peaceful cooperative world economy with increasing industrial activity, trade and gradual building up of the scale of living in Europe, South America and the Far East. This gives a rough picture of what the world has been, is producing and can produce to lubricate the

Table 2

Solvent Extraction Plants
Furfural Process

Refinery	Location	Est. Chg. Cap. B/D
Gulf Oil Corp.	Port Arthur, Texas	6,000
The Texas Co.	Lawrenceville, Ill.	2,400
The Texas Co. (3 plants)	Port Arthur, Texas	10,000
The Texas Co.	Los Angeles, Cal.	3,500
Magnolia Petroleum Co.	Beaumont, Texas	3,200
Shell Oil Co.	Martinez, Calif.	3,250
Quaker State Refining Co.	Farmer's Valley, Pa.	1,700
Quaker State Refining Co.	St. Mary's W. Va.	600
Quaker State Refining Co.	Emlenton, Pa.	1,700
Continental Oil Co.	Ponca City, Okla.	1,500
Golden Bear Oil Co.	Bakersfield, Calif.	500
British American Oil Co., Ltd.	Clarkson, Ont., Can.	2,000
Shell Refineries, Ltd.	Shell Haven, Eng.	1,650
Trinidad Leaseholds, Ltd.	Point-A-Pierre, Trinidad	2,910
Gewekshaft "Nerag"	Hanover, Germany	3,000
Cooperative Refinery Association	Coffeyville, Kansas	2,000
*Socony-Vacuum Oil Co., Inc.	Paulsboro, N. J.	3,000
*Magnolia Petroleum Co.	Beaumont, Texas	4,000
*Tide Water Assoc. Oil Co.	Bayonne, Texas	5,000
Sun Oil Co.	Marcus Hook, Pa.	2,000
*Consolidated Refineries Ltd. (2 plants)	Haifa, Palestine	10,000
*Anglo-Iranian Oil Co.	Abadan, Iran	1,500
*Cit-Con Oil Corp.	Lake Charles, La.	8,000
*Anglo-Iranian Oil Co.	Llandarcy, S. Wales	1,400
*Comp. Espanola de Petroleo S.A.	Tenerife, Canary Is.	900
*Shell Oil Co.	Cardon, Venezuela	6,000
*Societe Generale Huiles de Petrole	Dunkirk, France	2,000
*Burmah Oil Co. (Refineries) Ltd.	Syriam, Burmah	1,450
*Standard Oil Co. of Ohio	Toledo, Ohio	5,000
	Total	96,160

Phenol Process

Kendall Refining Co.	Bradford, Pa.	1,400
Imperial Oil Co.	Sarnia, Canada	2,500
Esso Standard Oil Co.	Bayonne, N. J.	1,750
Esso Standard Oil Co. (2 plants)	Baton Rouge, La.	7,000
Standard Oil Co. of Calif.	Richmond, Calif.	3,500
International Petroleum Co.	Columbia	300
Humble Oil & Refining Co.	Baytown, Texas	8,000
Union Oil Co. of Calif.	Oleum, Calif.	2,000
Sinclair Refining Co.	Houston, Texas	4,000
Gulf Oil Corp.	Port Arthur, Texas	3,100
*Sinclair Refining Co.	East Chicago, Ind.	6,000
*Shell Oil Co.	Houston, Texas	5,500
*Atlantic Refining Co.	Philadelphia, Pa.	3,000
*Phillips Petroleum Co.	Kansas City, Mo.	4,000
*Standard Oil Co. (In.)	Whiting, Ind.	6,000
*The Pure Oil Co.	Smiths Bluff, Texas	4,800
*Creole Petroleum Co.	Venezuela	2,000
	Total	64,850

Duosol Process

Socony-Vacuum Oil Co.	Paulsboro, N. J.	3,000
Magnolia Petroleum Co.	Beaumont, Texas	2,800
Gulf Oil Corp.	Girard Point, Pa.	2,500
Shell Refining Co.	Stanlow, England	2,000
Shell Petroleum Corp.	Wood River, Ill.	3,000
Standard Oil Co. of Calif.	Richmond, Calif.	8,500
Continental Oil Co.	Ponca City, Okla.	1,800
Sun Oil Company	Marcus Hook, Pa.	5,000
Champlin Refining Co.	Enid, Okla.	1,200
Attock Oil Co.	Rawalpindl, India	500
*Cit-Con Oil Corp.	Lake Charles, La.	7,200
*Union Oil Co., of Calif.	Oleum, Cal.	2,500
	Total	40,000

SO_2-Benzol Process

Tide Water Assoc. Oil Co.	Avon, Calif.	1,500
Shell Oil Co. of Calif.	Martinez, Calif.	1,500
Union Oil Co. of Calif.	Oleum, Calif.	1,500
Lobites Oil Fields, Ltd.	Ellesmereport, Eng.	500
Anglo-Iranian Oil Co.	Llandarcy, Wales	1,600
The Texas Co.	Port Arthur, Texas	1,000
Tide Water Assoc. Oil Co.	Bayonne, N. J.	2,000
Manchester Oil Refinery	Manchester, England	700
*Under construction	Total	10,300

Chlorex Process

Refinery	Location	Est. Chg. Cap. B/D
Standard Oil Co. (Ind.)	Wood River, Ill.	1,000
The Pennzoil Co.	Rousevile, Pa.	1,000
Mid-Continent Petroleum Corp.	Tusa, Oka.	900
Socony-Vacuum Oil Co., Inc.	Olean, N. Y.	1,700
Standard Oil Co. (Ind.)	Casper, Wyoming	600
Bradford Penn. Refining Co.	Clarendon, Pa.	500
	Total	5,700

Nitrobenzene Process

Atlantic Refining Co.	Philadelphia, Pa.	2,350
†Sinclair Refining Co.	Wellsville, N. Y.	800
	Total	3,150
Total solvent refining		220,160

†Nitrobenzene-Sulfuric acid

wheels of industry, railroads, automobiles, farm tractors, etc. Now let us look at the demand picture.

Lube oil demands prior to World War II paralleled the rate of increased consumption of fuels for automotive and industrial purposes. The Bureau of Mines figures[3] for production of lube oils show for 1938 a world total of 143,600 B/D with 84,500 B/D produced in U.S.A. Similar Bureau of Mines figures[2] show a breakdown of U.S.A. demands for lubes for 1938 to be 40 percent for automotive uses, 32 percent for industrial and 28 percent for export.

World lube consumption figures were studied by Garfias, Whitsel and Ristori[4] for 1938 and 1939 which showed consumptions of over 95,000 B/D in all countries outside the United States. These figures showing world lube consumptions up to 164,000 B/D follow:

Consumption of Lube Oils
Barrels per Day

	1938	1939
United States	58,000	69,000
Outside U. S. (Produced outside)	62,000	63,000
" " (Exported from U. S.)	36,000	32,000
" " Total	98,000	95,000
World Total	156,000	164,000

Since 1939 many important events have influenced the lube picture. The major factor was the war. This resulted in fewer lubricating oil plants being built from 1940 to 1945 since we were able to supply the war requirements with existing equipment and the steel was necessary for aviation gasoline, synthetic rubber, toluene and other plants. In addition, many of the operating lube plants in the war zones were partially or completely destroyed. The prosecution of the war also resulted in great developments in automotive and other equipment, i.e. higher speed engines, higher compression ratios, heavier duty engines, greater use of farm tractors and of diesel engines all of which tended to increase lube quality and demand requirements. Following the war other factors were the greatly increased demands created by increased use of automobiles, farm tractors, railroad diesels, high industrial and building activity. Automobile lube demands were higher than expected because less old cars were scrapped, new cars were again being manufactured on an increasing scale, mileage driven per owner increased, and ratios of lubes per gallon of gasoline went up (2.1 percent in 1940 to 2.7 percent in 1947).

Since over 40 percent of United States lube production goes to lubricate automobiles, it is of interest to look into this field first. The distribution of the use of gasoline gives an indication of where the lubes are used. The United States Department of Commerce[5] tells us that gasoline is consumed 64.5 percent by passenger cars, 21.6 percent by trucks and the balance by buses, tractors, military and miscellaneous, including export. The passenger cars, therefore, consume the greatest bulk of gasoline and, therefore, lube oils.

At the end of 1946 there were 28.1 million passenger cars registered. Roughly four million cars were produced in 1947, over five million will be produced in 1948 barring a major work stoppage in one of the three big companies, General Motors, Ford and Chrysler or several of the smaller ones. Half of this production was accomplished in the first half of this year even with a 17-day shutdown in Chrysler plants, two weeks or more in all G.M. plants and the stopping of Ford production for model change-overs. Estimating five million cars in 1948, 1949 and 1950 there would be at the end of 1950 47 million passenger cars not allowing for old car scrapping. If it is assumed that two million cars will be scrapped per year for these four years, the 1950 year end registration would reach 39 million cars. The number of cars scrapped is apt to be higher than during an average period since the average age of cars is about ten years as compared with a prewar age of about seven years. However, from 1927 to 1941 there were six years in which more than two million cars were scrapped and as many as 2,880,000 were scrapped in 1930.

Gasoline consumption per passenger car is of importance since lube oil consumption follows in more or less direct proportion. This consumption has increased from about ten barrels in 1925 to 15.33 barrels in 1941 and to 16.5 in 1946 according to Bureau of Mines.[5] The gradual trend towards increased consumption per passenger car will no doubt continue because the American public still likes larger cars, likes to drive faster and more comfortably, and has an increased desire to travel and is now building homes to an increasing degree in suburban and rural areas. Department of Commerce[5] estimates that 34.5 million passenger automobiles will consume an average of 17.5 barrels per car in 1950. The extent to which motor gasoline and, therefore, motor lubes will be consumed during the next five years will depend to a great extent on the economic status of the American public and the scale of living they are able to carry out. It should be noted here that the older cars on the road unquestionably consume more lube oils per gallon of gasoline than newer cars. However, it is also true that the American

public is paying more for its automobile today and is more careful to protect the engine and considers the operating costs of lubricating oil a small item compared with the life and protection of his investment.

Department of Commerce[5] estimates 5.7 million trucks registered at the end of 1946 will increase to 7.2 million trucks using gasoline in 1950, and 107,000 buses registered in 1944 to increase to 135,000 in 1950. With regard to farm trucks, the war stimulated the use of mechanized equipment on farms and the trend has been for greater use of gasoline for these units. The number of farm tractors in use in the States increased from 1,009,000 in 1943 to two million in 1945 and 2,800,000 in 1946. This trend is predicted to continue by farm industry authorities, with great improvements in power units including greater operating comfort and ease of handling tractors including independent running power take-off. According to manufacturers, this is a device by which power is supplied by shaft to a farm machine where the farm tractor operator will have full power at the take-off independent of the ground speed of the tractor. Department of Commerce[5] estimates that in 1950 3.2 million tractors will consume an average of 800 gallons of fuel per tractor of which 80 percent would be gasoline. Lube consumption for farm tractors is comparable to automobiles.

The increasing use of diesels for railroads are indicated by the consumption figures issued by Interstate Commerce Commission of 167,000 barrels in 1936, seven million barrels in 1944, ten million in 1945 and 12.5 million in 1946. The first diesel power main line passenger train was put in service in 1934 and in 1945 there were 3,401 diesel motors in service. There is a definite trend towards a conversion of the major portion of steam capacity to diesels and the annual diesel production capacity for railroads will have reached 1,000 units during 1948. The estimated demand for diesel fuel in 1950 by Department of Commerce[5] is 25.5 million barrels or more than double the 1946 consumption.

Since over the past ten years the consumption of lube oils for industrial purposes amounted to 32 percent of the United States production of lubes, we are interested in looking into industrial activity. The Federal Reserve Board production index, which uses 100 as the base average for the years 1935 to 1939, has been used by McIntosh[2] for prediction of lube oil demands in the industrial field. It represents production in factories and mines. These indices have averaged between 125 for 1940 and 239 for 1943. In the year 1946 this index was 171 average for the year but dropped to 159 in May due to strikes and reached 184 in the fall. The index for 1947 was 187 and for 1948 it is expected to average 189. It is predicted that this index will be between 180 and 190 for the next four years barring any major labor upsets. Based on these indices industrial lube requirements should remain between 45,000 and 50,000 B/D during the next five years and reflect increased lube demands in other fields as a result of the lube consuming units manufactured.

Taking an overall look at the world picture, the future demands for crude oil and all petroleum products requirements are expected to increase from approximately 8.3 million B/D of crude oil in 1947 to ten million or more B/D in 1951[6] Where the demand per capita in the United States was 13.9 barrels in 1947, the demand for the rest of the world excluding U.S.S.R. were only 1.4 barrels. There will, therefore, be considerable catching up to be done by the rest of the world in consumption of petroleum products as increasing demands of industry, mechanization of farms, modernization of railroads and increased automobile usage really gets under way in other countries outside the United States. With regard to lube oils outside the United States, the production for 1938 of about 60,000 B/D dropped to practically nothing at the conclusion of the war. Exports from this country were short of requirements over the past few years but reached 40,000 B/D in 1947. Figures given previously in this paper show the estimated production up to 1951. It is evident from these figures that exports will continue at a high rate from this country and that a great deal depends on how fast Europe, South America and the Far East develop their industries, use of automobiles, diesels for railroads and farm tractors for farms as to how great these demands will be. The potential is definitely very great and pessimistic predictions may be found to be considerably in error.

This paper has presented lists of solvent refining and solvent dewaxing lubricating oil plants both operating and now under construction with estimated capacities. Production figures available through 1947 and estimated available production through 1951 have been given for both this country and the rest of the world. The demand picture has been discussed for lubricating oils and it seems evident that demands for lube oils for passenger cars in the United States will increase with increased cars on the road and increased driving by the American public. Industrial activity is expected to remain at least at the present rate and consumption of lubes for this field should increase. Farm tractors and diesel engines will call for additional amounts of lubes. Foreign countries should increase industrial activity, use of automobiles, tractors, diesel engines and create increased demands. In brief, there is no present indication that the world demands for lubes will be completely met in the years to come even with the larger number of lube plants now being constructed.

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Table 3

Solvent Dewaxing Plants
MEK-Benzol Process

Refinery	Location	Est. Chg. Cap. B/D
The Texas Company	Lawrenceville, Ill.	1,400
Atlantic Refining Co.	Philadelphia, Pa.	600
Gulf Oil Corp.	Port Arthur, Texas	1,500
Socony-Vacuum Oil Co., Inc.	Paulsboro, N. J.	3,800
The Texas Co. (2 plants)	Port Arthur, Texas	5,000
Socony-Vacuum Oil Co., Inc.	Olean, N. Y.	2,850
Quaker State Refining Co.	Farmers Valley, Pa.	1,800
Magnolia Petroleum Co.	Beaumont, Texas	3,400
Tide Water Assoc. Oil Co.	Bayonne, N. J.	1,200
Standard Oil Co. of Calif. (2 plants)	Richmond, Calif.	5,500
Sinclair Refining Co.	Wellsville, N. Y.	4,500
Continental Oil Co.	Ponca City, Okla	1,300
Sinclair Refining Co.	Houston, Texas	3,500
Quaker State Refining Co.	Emlenton, Pa.	1,200
British American Oil Co. Ltd.	Clarkson, Ont., Can.	1,600
Sun Oil Corp.	Marcus Hook, Pa.	3,500
Gulf Oil Corp.	Port Arthur, Texas	2,200
Petrolite Corp.	Kilgore, Texas	100
Shell Refineries, Ltd.	Shell Haven, Eng.	1,600
Attock Oil Co., Ltd.	Rawalpindi, Pakistan	450
Shell Refineries, Ltd.	Stanlow, England	1,300
The Pennzoil Co.	Oil City, Pa.	3,000
Gewerkshaft "Nerag"	Hanover, Germany	1,800
Imperial Oil Co.	Sarnia, Ontario	2,500
U. S. S. R.	Russia	1,800
Atlantic Refining Co.	Philadelphia, Pa.	3,500
Humble Oil & Refining Co.	Baytown, Texas	4,500
*Sinclair Refining Co.	East Chicago, Ind.	5,200
*Shell Oil Co.	Houston, Texas	4,800
*Pure Oil Co.	Smiths Bluff, Texas	4,200
*Socony-Vacuum Oil Co.	Paulsboro, N. J.	3,000
*Magnolia Petroleum Co.	Beaumont, Texas	4,800
*Esso Standard Oil Co.	Baton Rouge, La.	4,500
*Sun Oil Co.	Marcus Hook, Pa.	2,000
*Tide Water Assoc. Oil Co.	Bayonne, N. J.	1,500
*Consolidated Refineries Ltd. (2 plants)	Haifa, Palestine	7,500
*Anglo-Iranian Oil Co.	Abadan, Iran	1,000
*Cit-Con Oil Corp. (2 plants)	Lake Charles, La.	7,500
*Anglo-Iranian Oil Co.	Llandarcy, S. Wales	1,000
*Burmah Oil Co.	Syriam, Burmah	3,500
*Comp. Espanola de Petroleo, S.A.	Tenerife, Canary Is.	700
*Cooperative Refinery Association	Coffeyville, Kansas	2,000
*Internation Waxes Ltd.	Agincourt, Ontario	150
*Shell Oil Co.	Pernis, Holland	4,200
*Societe Generale Huiles de Petrole	Dunkirk, France	1,500
*East Standard Oil Co.	Bayonne, N. J.	7,500
*Standard Oil Co. of Ohio	Toledo, Ohio	3,600
*Sun Chemical Co.	Chanute, Kansas	100
*Shell Oil Co.	Cardon, Venezuela	4,000
*Standard Oil Co. of Calif.	Richmond, Calif.	1,500
*The Texas Company	Port Arthur, Texas	8,750
Total		149,800

*Under construction

Propane DeWaxing Process

Standard Oil Co. (Ind.)	Wood River, Ill.	1,300
Union Oil Co. of Calif.	Oleum, Calif.	1,300
Shell Petroleum Co.	Wood River, Ill.	3,600
Kendall Refining Co.	Bradford, Pa.	1,200
Humble Oil & Refining Co.	Baytown, Texas	3,700
Esso Standard Oil Co.	Baton Rouge, La.	2,200
*Phillips Petroleum Co.	Kansas City, Mo.	3,000
*Standard Oil Co. (Ind.)	Whiting, Indiana	4,000
*Creole Petroleum Corp.	Venezuela	600
Total		20,900

SO_2-Benzol Dewaxing Process

Anglo-Iranian Oil Co.	Llandarcy, Wales	1,600
Lobitos Oil Fields Ltd.	Ellesmereport, Eng.	350
Manchester Oil Refinery	Manchester, England	450
Total		2,400

Barisol Process

Esso Standard Oil Co.	Baton Rouge, La.	1,800
Continental Oil Co.	Ponca City, Okla.	400
Total		2,200
Total dewaxing		175,300

*Under construction

PETROLEUM INDUSTRY GREATLY EXPANDS RESEARCH

IT is difficult to estimate with exactitude the value of research to the oil industry and to consumers of oil products. Some impression of its meaning may be conveyed by the fact that in the past quarter century during which time scientific studies of the nature of oil and its potentialities have been systematically pursued the cost of gasoline has been reduced fifty percent while the supply of usable products from a given quantity of crude has been multiplied manyfold.

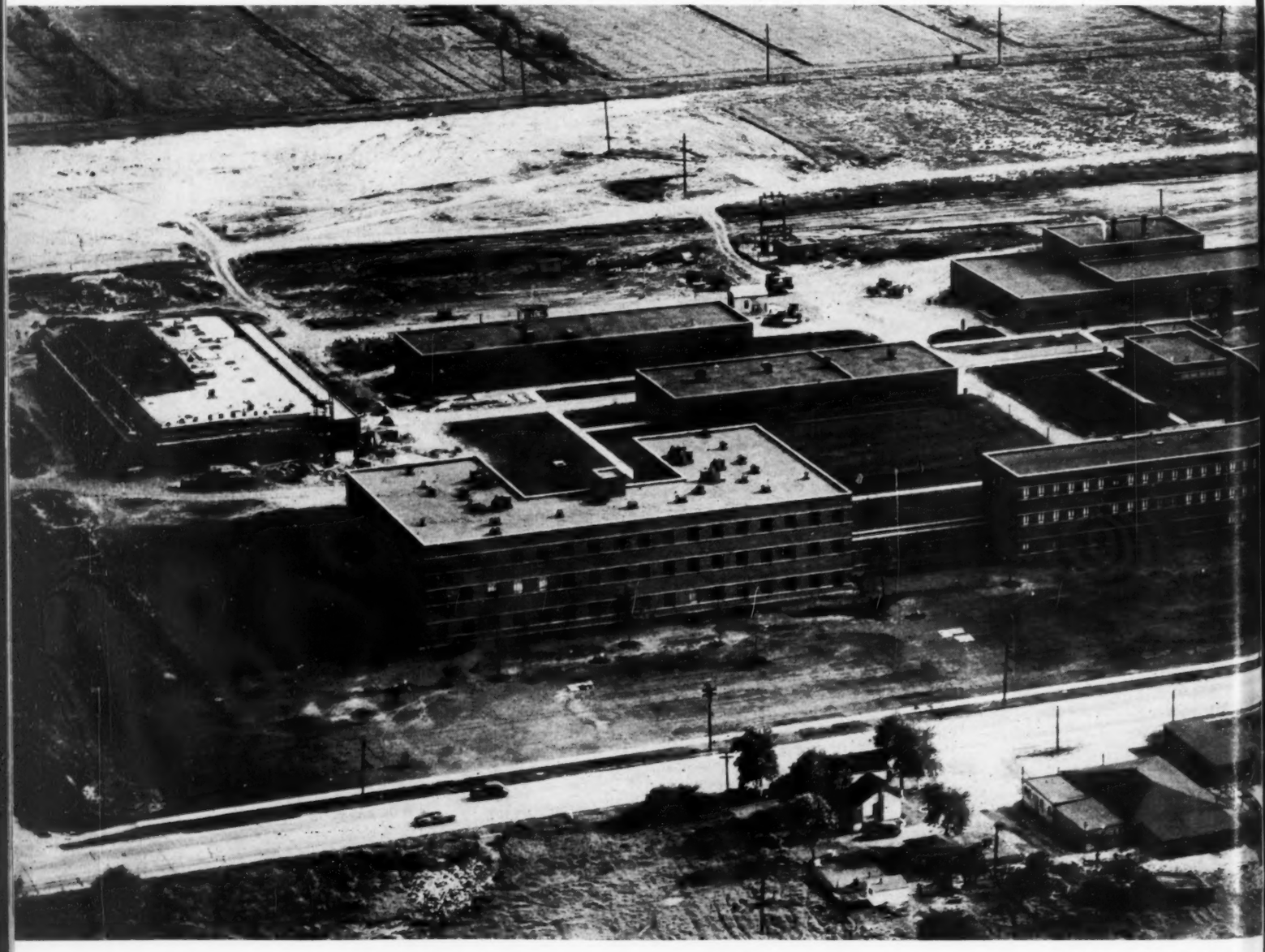
While research has played its part in petroleum progress from the beginning of the industry the establishment of separate divisions devoted entirely to study and experimentation dates back to the period of World War I. In 1919 Standard Oil Company (N. J.) which was a pioneer in this field set up a staff of workers to seek out methods of improving techniques and products. The group included 26 persons. A measure of the growth in research activities since that time is afforded by the fact that a subsidiary corporation of the company is now engaged exclusively in this field and that the number of its employes is one hundred times the original working force.

Based on a recent inquiry covering a representative group of American oil companies it is estimated that not less than 15,000 persons are devoting their time and energies to the study and analysis of oil, the development of more efficient and economical processes of treatment and the discovery of new products and applications. The yearly expenditure in this connection approaches $500 million.

Viewed from a strictly commercial angle most of the companies carrying on large scale research consider that the millions spent upon it have been profitably invested. Financial returns have come from the savings of large sums that otherwise would have been paid out in license fees to others for the use of patented processes, from savings in costs through improved techniques and in profits from the development of new products. These gains have been shared with consumers through lowered prices, the enjoyment of better fuels and lubricants and the use of many valuable products previously unknown.

Research proved itself of incalculable value in contributing to national security during World War II. As a result of study and experimentation carried on by private companies over the preceding decade or longer the industry was in a position to provide the vast quantity of high octane gasoline needed to fuel tens of thousands of airplanes. It made available a satisfactory substitute for natural rubber when imports were shut off. It was the source of explosives and chemicals essential to the prosecution of the war. Achievements made in the ordinary course of

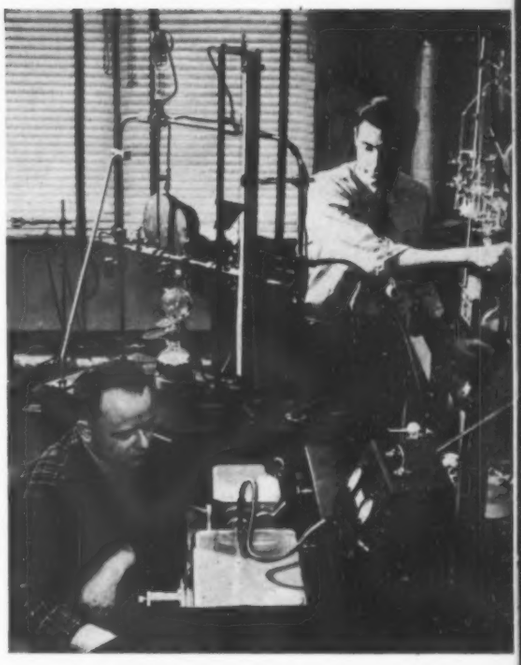
New research center of Sinclair Refining Co. at Harvey, Ill.



oil industry operation gave it a leading place in the march to victory.

In the brief period since the close of the war great expansion has taken place in the facilities and manpower devoted to oil research. Vast new laboratories have been erected filled with a bewildering array of apparatus and the scope of investigation has been extended to every phase of the industry's operations. In some cases special attention is directed to the branch of the industry with which a particular company is concerned. Thus a company that is primarily interested in production naturally will concentrate its attention on problems relating to the discovery of oil, to drilling, and to developing efficient methods of recovering oil from its reservoir. A refining company may specialize in the study of processing and the finding of new or better products. A large integrated company will have an interest in extending its investigations to both these fields and to other branches of industry activity. In such cases it may establish laboratories or pilot plants in several different localities. For example Shell Oil Company has just completed a research center at Houston, Texas, which will specialize in the study of exploration and production while its chemical affiliate operates a laboratory and experimental farm in California for the testing of insectides and fungicides and other matters affecting the relationship of oil and agriculture. The company's general research is conducted at the plant of Shell Development Company at Emeryville, California.

At Harvey, Illinois, Sinclair Refining Company has just completed a large plant to house its principal research activities. This has been laid out according to approved modern design with separate buildings devoted to various fields of investigation. These include the main laboratory building assigned to general research, a fuel application laboratory, a pilot plant building, a laboratory for lube treating, compounding and distillation studies, an engine laboratory and another used for exploratory research. These of course are in addition to an administration building, power plant, shops and facilities for the use and convenience of employes. The spacious site selected will permit additions to be made to the various buildings as may become necessary.

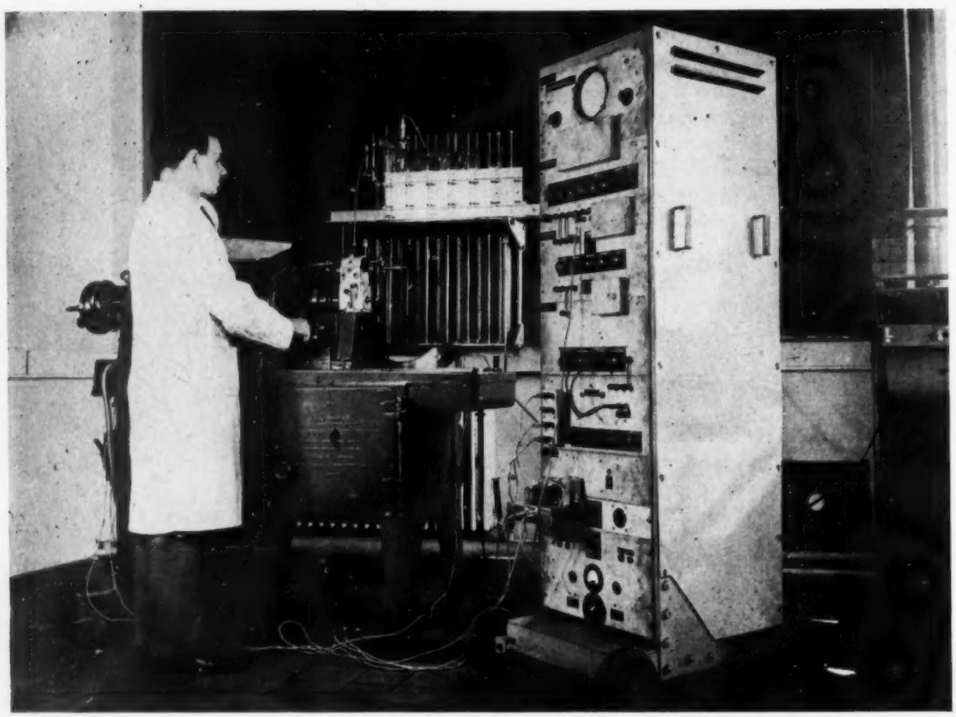


Infrared spectrometer, one of the physical test methods coming into wide use. Standard Oil Co. (Ind.) photo.

At Whiting, Indiana, Standard Oil Company (Indiana) has constructed a great new research center which provides occupation for more than a thousand workers and is maintained at an annual expenditure of over six million dollars. It handles general research and development problems as well as process design for the company's refineries. In addition subsidiary companies maintain large research laboratories such as that of Stanolind Oil and Gas Company at Tulsa which is engaged particularly in studies of gas synthesis and that of Pan American Petroleum Corporation at Texas City which has as its special field the utilization of petroleum in the manufacture of chemical products.

One of the leading research centers of the country is that of Universal Oil Products Company at Riverside, Illinois, which has contributed in many important ways to the advances in petroleum processing. Its work covers a wide range of subjects from pure science to the design of practical equipment for the utilization of advanced operating methods and valuable new products.

Cooperation between independent research organizations and oil companies is a fruitful source of industrial progress. It is exemplified in the joint program that is being carried out by M. W. Kellogg Company in conjunction with Cities Service Company. It deals particularly with the synthesizing of liquid fuel and chemical by-products from natural gas, a subject of common interest to the two groups from the fact that Cities Service is one of the leading producers of natural gas while the Kellogg Company has been engaged for many years in intensive study of its applications. In the same field Hydrocarbon

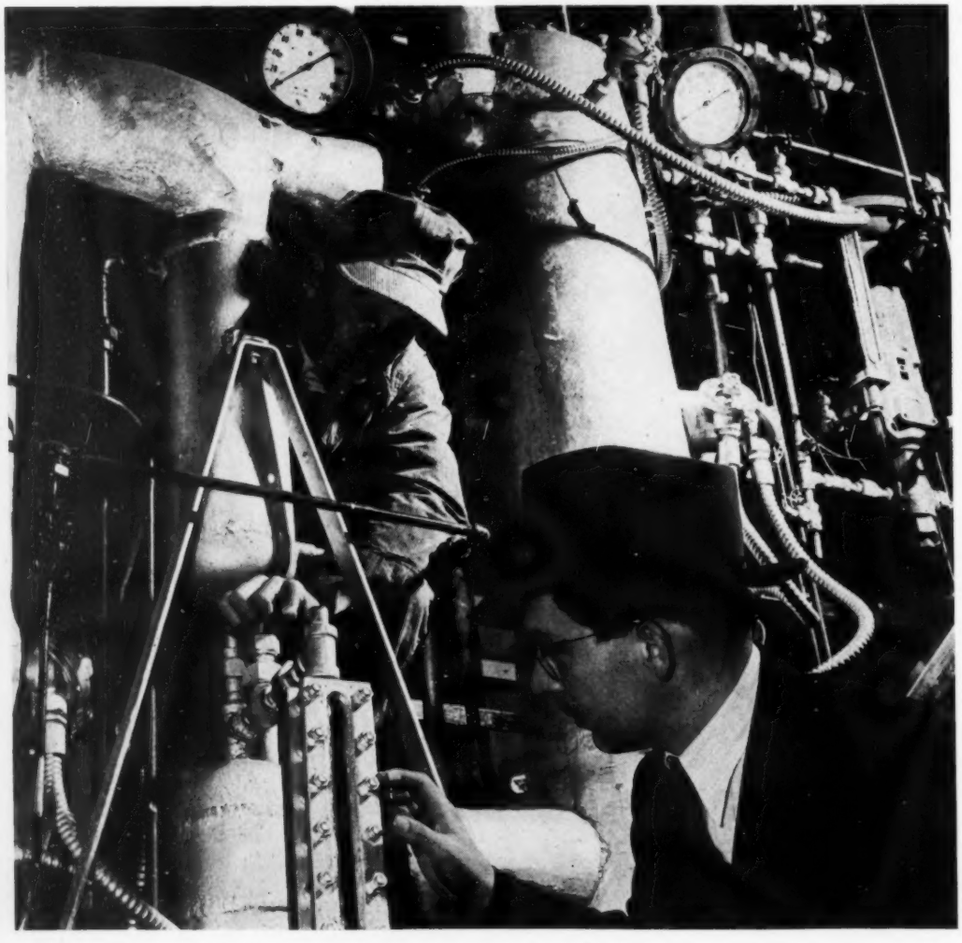


Single cylinder injection pump on test-bench with Oscilloscope recording injector needle lift in the recently built Shell research center at Thornton-le-Moor, near Chester, England.

Research Inc. has been carrying on progressive pilot plant experimentation with the financial backing of The Texas Company and others which is now resulting in the construction of a plant for commercial utilization of the process that has been developed.

Scientific and technical studies in which Gulf Oil Corporation has been engaged for many years expanded to a point where a separate subsidiary company, Gulf Research and Development Corporation, was set up to handle them. This company is just completing work on its research center at Harmarville, Pennsylvania. Gulf's research has dealt with the behavior of oil fields and the means of increasing recovery and reducing drilling costs. In the field of refining it has led to the development of a special polyform process, to increased production of critically short products such as middle distillates and the utilization of former waste products. A spectacular Gulf development was the flying magnetometer which rendered vital service during the war in the detection of enemy submarines and has since been employed in oil surveys in marine and land areas difficult of access by other means.

Part of Imperial Oil's two story pilot plant where research is being carried out.

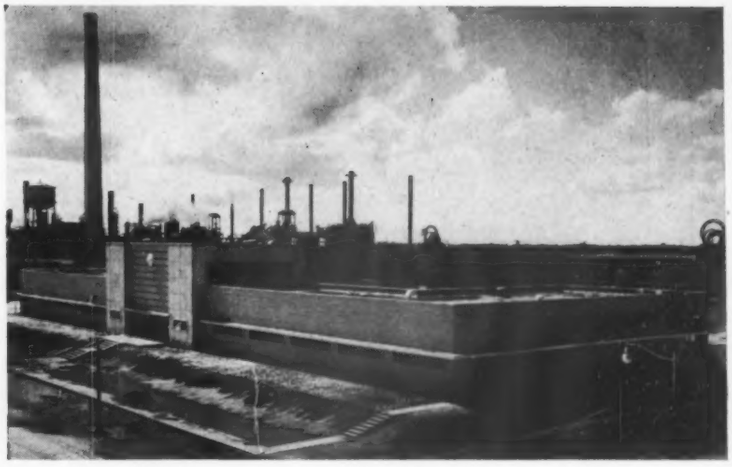


Sun Oil Company has organized a special research and development department to handle its extensive research activities on which the company spends upward of four million dollars annually. The company has under way the construction of a research center at Newton Square, Pennsylvania, the first unit of which, a physical research laboratory, was placed in operation a few weeks ago. The department will direct its efforts toward the development of new processes and the improvement of those now in use. Subjects under active study include catalytic cracking, solvent extraction, synthetic fuel processes and product applications related to new automotive and industrial developments.

Many current research activities are concerned with new types of fuel and new sources of supply demanded by recent developments. The Texas Company, for example is conducting studies in jet fuels at its laboratories at Beacon, New York. Other laboratories are maintained at Lawrenceville, Illinois, Port Arthur and Port Neches, Texas, and recently a new station was established at Montebello, California. As previously mentioned Texas is a participator in the studies of gas synthesis conducted by Hydrocarbon Research Inc. In addition to the work carried on in its own laboratories the Texas Company sponsors a number of fellowships and research projects in colleges and universities.

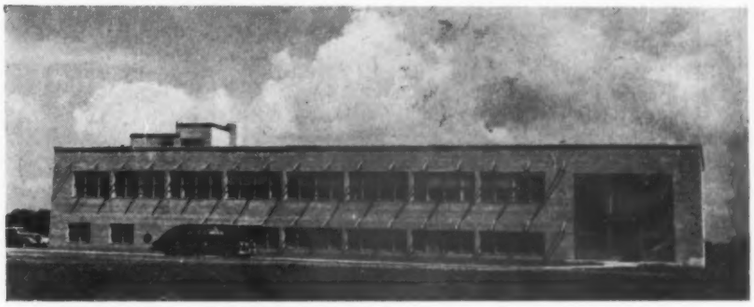
On the Pacific Coast Standard Oil Company of California has long been engaged in extensive research activities which are incorporated in the California Research Corporation. During the past year these activities have been largely stepped up in its laboratories at Richmond, El Segundo and La Habra, California. Largest of these laboratories, adjacent to the Richmond refinery, was completed in March last after an expenditure of two million dollars on its expansion. New units include a two-story process laboratory and an extension to the main administration and research laboratory building. The project also includes remodeling of some structures and the installation of a cold room section where temperatures may be kept as low as minus 50° F. A fully equipped machine shop is another addition and space is provided for large scale equipment and pilot plants. More

One wing of the new Shell research laboratories near Chester, England.



New Shell laboratories at the Deer Park, Texas, refinery.

Standard Oil Co. (Indiana) is expanding its Whiting research laboratories to house 1140 scientific workers.



Newly completed physics laboratories of the Sun Oil Co. at Newton Square, Pa.

than 850 persons constitute the working staff of the Research Corporation.

The duPont Company which is directing increasing attention to the oil industry has established a research laboratory at Wilmington, Delaware, under the direction of its Petroleum Chemicals Division with branches at Tulsa, Chicago and El Monte, California, with others to be added later.

It is clearly impossible within the limits of a single article to give details of the work being carried on by the many research organizations of American oil companies or even to list the thousands of new products resulting from their activities. Enough has been shown to demonstrate that research facilities are being rapidly expanded and to prove that the oil industry is fully alive to its responsibilities and its opportunities for future public service.

Across the border in Canada, Imperial Oil Ltd., operates a research laboratory at Sarnia, Ontario. Currently its studies are being directed to suspensoid catalytic cracking, catalytic finishing of lube oils and the production of new types of waxes. A noteworthy achievement at Sarnia was the development of the suspensoid catalytic cracking process. This process is now in commercial operation but its originators believe that further studies in the direction of improved catalysts and operating techniques are justified.

Across the Atlantic the large oil companies of the United Kingdom maintain large and constantly growing research organizations. The great Sunbury laboratories of Anglo-Iranian Oil Company Ltd. are widely known for their achievements and are steadily expanding the scope of their operations. In May last the Shell group of companies formally dedicated the latest additions to its research center at Thornton-le-Moor, Chesire, near the company's Stanlow refinery. The staff of the research center numbers some 900 persons. Some of the subjects under study include the characteristics of high octane gasoline, base fuels for gas turbines, diesel fuels, lubricating oils and the production of chemicals from petroleum.

Other large research organizations are maintained by Esso Development Co. Ltd., Burmah Oil Co. Ltd. and Trinidad Leaseholds Ltd.

Inspection laboratories of the petroleum chemicals division of E. I. du Pont de Nemours & Co. which recently added tetraethyl lead to the group of chemicals manufactured for oil refiners.

Naphtha fractionating unit.

FRACTIONATION OF NAPHTHAS

By Harry Litwin*

THE Roosevelt Oil Co., Mt. Pleasant, Mich., has been operating for approximately a year new refining facilities which represent major improvements to the plant. They are a new crude unit, Perco regenerative type catalytic desulfurization unit and a close cut naphtha fractionating unit designed and constructed by Koch Engineering Co. A novel feature in this modernization program was the use of Koch Kaskade fractionating trays throughout all the new towers.

The former crude system consisted principally of a two coil furnace and two 5'-0" dia. fractionators operated in series. From No. 1 tower, low end point gasoline was taken overhead and two naphtha fractions off the side. The No. 2 tower produced kerosene off the top, distillate or diesel fuel and gas oil off the side.

The heavier gasoline fractions boiling below 400° F. were generally sold as naphthas since the clear knock ratings and lead susceptibilities of these materials from Michigan crude were too low for sale as regular motor fuel. The maximum crude capacity of this system was approximately 5,000 barrels per day.

As part of the revamping program two new furnaces were to be installed initially to replace the former furnace. Prior to completion of the installation a new 6'-0" dia. Kaskade tray tower was ordered to replace the No. 2 tower which had suffered severe corrosion. The new tower was designed to serve either as No. 2 tower or in the future, to replace both towers in distilling the crude. Before the Kaskade tower was installed severe corrosion was found also in No. 1 tower so that the new tower was arranged to perform all the crude distillation. The new Kaskade tray tower was lined with 11-13% chrome throughout except for the space above the two top trays, where Monel lining was provided to resist acidic corrosion. The trays were constructed of 11-13% chrome except the two

*Vice-President The Koch Engineering Co., Wichita, Kansas.

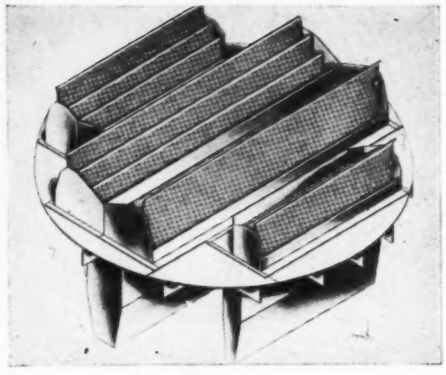


Figure 1: Drawing of crude fractionating tray.

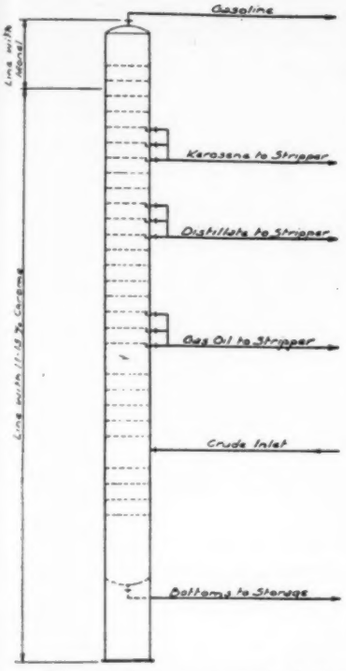
at the top which were made of Monel. Twenty-four fractionating trays and four stripping trays were provided. An isometric view of the trays is shown in Figure 1.

A sketch of the crude tower is shown in Figure 2. In operation this tower takes overhead a long range naphtha cut of approximately 450° F. end point which is charged to the Perco unit. Kerosene, distillate and gas oil are taken off the side of the tower. The pressure drop at a crude charge rate of 8,300 barrels per day is less than 3 inches of water per tray. After a year of operation no plugging or increase in pressure drop have been experienced.

The new tower was designed to process 7,500 barrels per day, removing in overhead and side streams 70% of the crude. The actual throughput has reached 9,000 barrels per day without overloading or causing excessive pressure drop in the column. At this rate the vapor load at the top of the tower was 210% of that indicated by the Brown-Souders mass velocity formula.[1] Furnaces and condensers have limited the throughput to this tower and by removing these bottle-necks and employing intermediate refluxing it is expected that the capacity could be increased to 15,000 barrels per day.

Although this refinery does not have a cracking unit the installation of the Perco desulfurization unit permits the production of good quality motor fuels from the relatively low octane straight run gasoline. Depending upon market demand the gasoline is blended into motor fuel or fractionated into a series of high quality solvent naphthas. The Perco unit was designed to permit high temperature catalytic reforming as well as desulfurization, but at the present time the required octane values of the gasolines are obtained under mild conditions. As octane requirements increase, the catalytic reforming operation can be carried out at higher temperatures to produce the desired products.

The flow chart of the Perco unit is shown in Figure 3. The crude fractionator reflux drum serves as a feed accumulator for the Perco unit. The accumulator level is maintained by a liquid level controller which admits kerosene from storage. The feed is preheated by heat exchange with catalyst chamber effluent before entering the furnace where it is heated to approximately 800°



Fifiure 2: Tray arrangement of 6'-0" diameter crude fractionator.

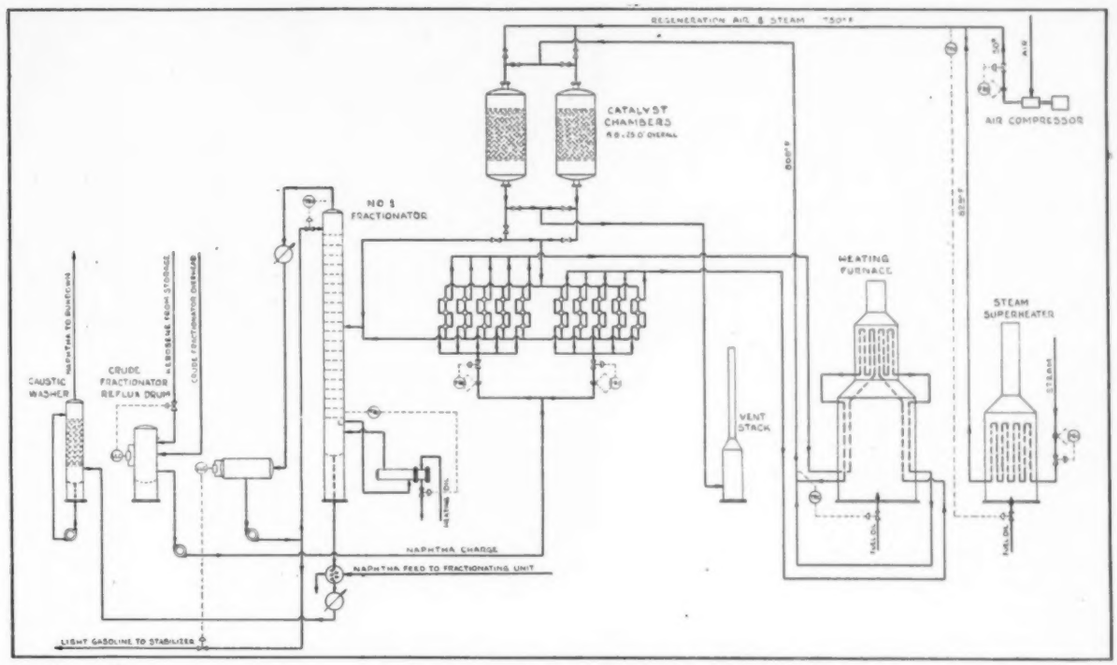


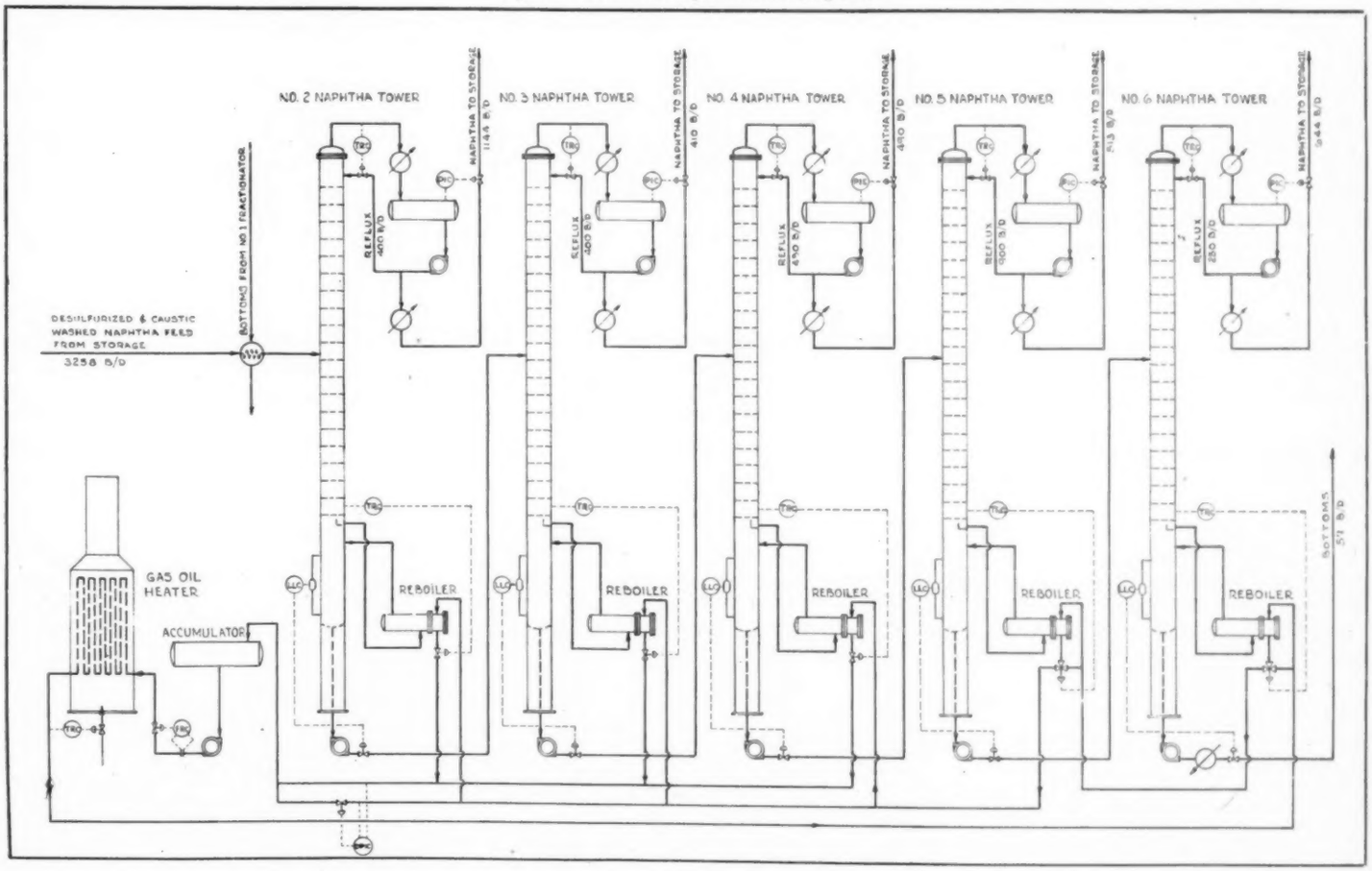
Figure 3: Flow Chart of Perco catalytic desulfurization unit.

F. The vapors pass into the catalyst chamber filled with natural bauxite catalyst. After a chamber has been operated on process for several days it is regenerated by means of superheated steam and air while processing is continued in the other chamber. The vapors leaving the chamber are partially cooled in the effluent exchangers and pass into the fractionator. The 4'-0" dia., 20 Kaskade tray fractionator was designed for two widely varying conditions:

1. Taking overhead all the vapors except approximately 2% of polymers produced in reforming operation.
2. Taking overhead 15-20% of the vapors for stabilization when desulfurizing the charge to produce motor gasolines or naphthas.

The fractionator has been operated successfully for either of these conditions.

Figure 4: Flow chart of naphtha fractionating unit.



Total sulfur reduction in the Perco unit is 80-90%. The motor octane number of the desulfurized full range gasoline containing 3 cc of lead is 12-16 points higher than that of the undesulfurized 3 cc leaded gasoline. The process loss is nigligible.

Naphtha fractionation may be performed in several ways but we feel the simplest and most flexible method is the use of a series of fractionators, with a fractionator for each simultaneous cut to be produced.

The unit installed at Roosevelt contains a total of six fractionators, so that six overhead naphthas can be obtained simultaneously. No. 1 fractionator is operated in conjunction with the Perco catalytic unit and the remaining five fractionators in series operate as part of the naphtha unit.

Each of the naphtha fractionators is 3'-0" diameter, and contains only twenty trays. Bubble tray towers of the same capacity and separating efficiency would have been 4'-0" in diameter, containing thirty trays or more. The use of Kaskade fractionating trays thus permitted a major saving, both in investment cost and operating expense.

The process flow chart of the naphtha fractionating unit is shown in Fig. 4. The Perco desulfurized and caustic washed long range naphtha cut is preheated by heat exchange and charged to the middle of No. 2 fractionator. The overhead naphtha product is condensed and flows into the reflux drum, from which reflux is returned to the top of the fractionator and net product is pumped through an aftercooler to storage. The bottoms are reboiled in a thermosiphon type reboiler and are pumped as feed to the middle of No. 3 fractionator, where another naphtha product is taken overhead. The operation is repeated through No. 4, 5, and 6 fractionators. Heating oil for all reboilers is furnished by a closed gas oil system including furnace, accumulator and pump.

Distillations of the feed, overhead, and bottoms for each tower are shown in Table I. Following No. 2 tower, the feed to each tower is of course the bottoms from the preceding tower.

The ratios of reflux to overhead, which vary from 0.35 to 1.75 as shown in Table II, are quite low for the separations obtained. The low reflux ratios result, of course, in minimum fuel and cooling water requirements. When charging 3,500 barrels per day to the series of fractionators, the total reboiler load is less than 10,000,000 Btu/hr. Incidentally, no stripping steam is used in any of the towers.

Studies have not yet been completed to determine tray efficiencies obtained in this unit. Preliminary figures indicate that well over 100 percent efficiency is attained in all the towers except No. 3, where the efficiency is approximately 70 percent while operating under a relatively low load.

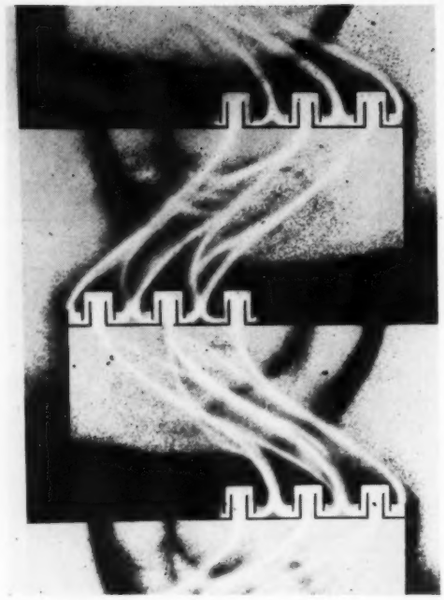


Figure 5: View of conventional bubble tower, showing backflow through risers and vapor crossing.

Instrumentation of the naphtha fractionation unit required careful study. It was planned to provide instrumentation at lowest cost which would give automatic control with minimum attention from the operators. The instrumentation, moreover, was to be capable of simple adjustment to change specifications of products. At the same time, it was essential for the instruments to recognize and handle properly, changes in quantity and composition of feed. Composition changes occur rather frequently on this unit, because of variations in crude and inclusion of outside purchased gasolines. The changes in composition may occur quite quickly, so that the loading of a particular tower may double in a very few minutes. Fortunately, the Kaskade tray adjusts itself very rapidly to changing conditions because of the especially low liquid holdup on the trays, which is a small fraction of the holdup occurring on bubble trays.

Flow control was used for No. 2 tower feed but liquid level control was used to feed the succeeding towers. Feed flow controls would have been preferable from the standpoint of smoothing operation of these towers, but would have required more attention from the operators. Liquid level controls arranged to reset flow controls would have helped somewhat, but for this relatively small unit, it was felt the additional expense was not justified.

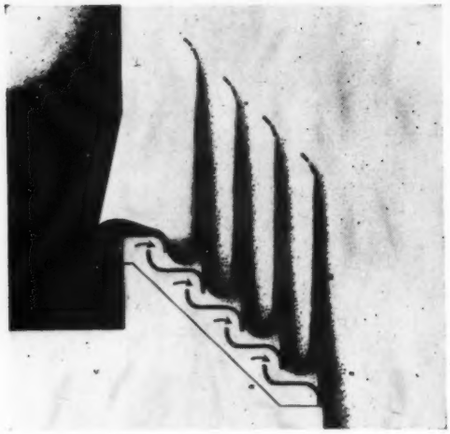


Figure 6: View of vapor and liquid flow in kaskade tower showing uniformity and efficiency of fractionation.

Temperature controls were used to control top reflux and heating oil to reboilers. Since the boiling range of each overhead product is approximately 40° F. or greater, it was decided the best control at the top would be that of temperature controlling reflux. The temperature control at the bottom of the tower, controlling heating oil to the reboiler, takes care of fluctuations in feed rates. The bottom temperature control is adjusted by the operator to give the desired amount of top reflux. This instrumentation in operation has proved quite satisfactory.

The pressure controller on the reflux drum, which serves both to control tower pressure and to release the net overhead product, is worthy of mention. Normally, in cases where the overhead is totally condensed, a back pressure controller is used ahead of the condenser to control tower pressure while another pressure controller by-passes vapors around the condenser for reflux drum pressure control. Alternately one pressure controller with 3-way valve may be used to by-pass vapors around the condenser. In addition to pressure controls, a liquid level controller is often used to release net product. All these services are handled very nicely by the pressure controller shown in Figure 3.

The Koch Kaskade tray was developed in order to eliminate the well-known disadvantages and

Table I

A.S.T.M. Distillations for Naphtha Products*
Temperatures in Degrees Fahrenheit

%Distilled	Charge	No. 2 Tower Ovhd.	No. 2 Tower Btms.	No. 3 Tower Ovhd.	No. 3 Tower Btms.	No. 4 Tower Ovhd.	No. 4 Tower Btms.	No. 5 Tower Ovhd.	No. 5 Tower Btms.	No. 6 Tower Ovhd.	No. 6 Tower Btms.
I.B.P.	115	65	193	185	250	223	320	298	386	377	470
5	165	77	214	187	265	231	330	303	391	381	473
10	190	86	230	188	277	235	337	306	393	385	476
20	220	100	253	191	295	236	345	312	396	390	479
30	245	109	271	194	311	238	353	316	399	394	481
40	264	113	286	197	328	243	361	320	402	396	482
50	289	120	306	200	346	248	372	323	406	399	482
60	318	136	332	204	365	252	384	329	411	403	484
70	346	143	360	210	385	258	398	337	418	408	488
80	378	150	385	218	405	264	416	341	427	416	495
90	415	160	414	230	427	275	437	350	443	425	510
95	437	169	436	240	440	285	452	362	455	432	521
E.P.	460	180	461	253	465	300	475	389	474	439	542

* Charge to tower is the bottoms from preceding tower.

limitations of the conventional bubble tray. One fault of the bubble tray is poor contacting—even under normal conditions the contacting is limited principally to that taking place as the vapor passes through the slots in the caps, with very little further contacting occurring before the vapor passes to the next tray above. Another fault is excessive pressure drop, caused by the high vapor velocity in its tortuous path through the cap, and the liquid head above the slots.

The major fault in the bubble tray is the liquid gradient which is built up from the inlet to the outlet side of the tray, so that the head to be overcome by the vapors is not uniform. This allows a greater quantity of vapor to pass through the caps on the liquid outlet than on the inlet side. As the load increases, the gradient increases until no vapor flows through the caps on the inlet side of the tray, thus permitting liquid to flow down the risers without contacting the vapors, as illustrated in Figure 5. Since all the vapor must then flow through the caps on the outlet side of the tray, the velocity increases, with resulting increase in pressure drop. The vapor velocity becomes so great that some of the liquid is blown off the tray, resulting in very poor contact and excessive entrainment. As the load increases still further, the pressure drop increases rapidly until it exceeds the available head in the downpour, and the tower surges and floods over the top.

By contrast, the operation of the Koch tray is pictured in principle in Figure 6. In this apparatus, liquid entering through a downpour from the tray above is fed into one of the parallel vapor streams entering from the tray below, and the resulting mixture is thrown violently against a solid plate to which is attached a perforated baffle. The velocity of the mixture creates considerable centrifugal force as the mixture flows along and up the baffle, forcing all of the liquid and a portion of the vapor through the perforations. As the load increases the froth is thrown higher along the face of the baffle.

The liquid separates from the vapor on the opposite face of the baffle in a vigorous bubbling action and feeds into the next trough, where the operation is repeated. As the liquid passes through the last perforated baffle, it drops into a downpour to be fed into the tray below. A major portion of the vapor passes upward along the near side of the baffle and is deflected by the backwardly curved edge at the top, to stop any liquid entrainment. For further description of the principles involved in the design and operation of the Koch tray, the patent[2] may be consulted.

Due to the stair-step arrangement of troughs, there is no chance for liquid build-up, so that very large quantities of liquid can be handled. Moreover, since all the liquid passes into each trough successively, all the liquid receives the same treatment. Due to the violence of vapor-liquid mixing, the liquid is broken up into very fine droplets so that high fractionating efficiency is obtained, even with cold and relatively viscous oils such as found in absorbers. Furthermore, a large contacting surface is provided by the perforated baffles.

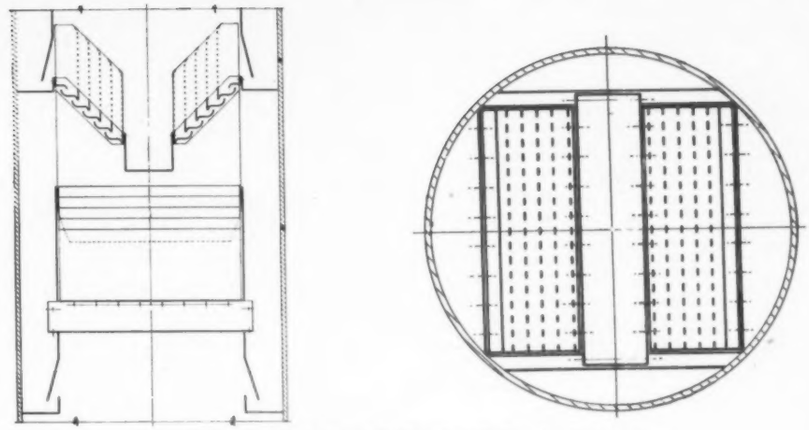


Figure 7: Elevation and plan of 3'-0" and 4'-0" diameter Kaskade trays.

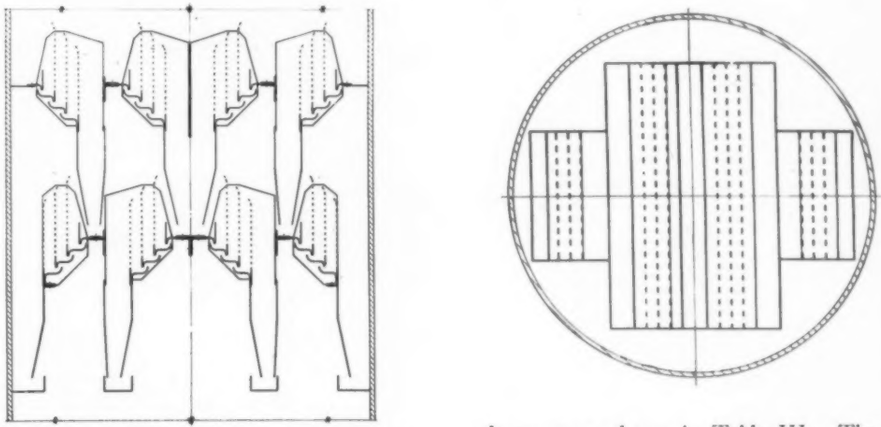


Figure 8: Elevation and plan of 6'-0" diameter Kaskade tray.

With the Kaskade design greater vapor areas, downpour areas, and weir lengths are provided concurrently than can be obtained in the bubble tray. These dimensions provided in the Roosevelt trays are shown in Table III. The arrangement of the 3'-0" and 4'-0" diameter naphtha fractionating trays is shown in Figure 7. The arrangement of the 6'-0" diameter crude fractionating tray is shown in Figure 8.

With the elimination of practically all liquid head to be overcome by the vapors plus provision of ample vapor and liquid passages, the pressure drop through the Koch tray, as confirmed both by laboratory tests and commercial operation, is less than half that through a bubble tray at the same load. At the same pressure drop the capacity of the Koch tray is often double that of the bubble tray.

The Koch trays are constructed of light gauge plate arranged in sections designed for easy insertion or removal through a manway. These sections are bolted to the tray supports. Standard designs of Kaskade trays are available to fit any size of tower from 2'-4" diameter upward.

Table II

Operation Summary—Kaskade Fractionating Towers Naphtha Unit

	No. 2 Naphtha	No. 3 Naphtha	No. 4 Naphtha	No. 5 Naphtha	No. 6 Naphtha
Type of Column					
Diameter (I.D.)	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
Number of trays	20	20	20	20	20
Charge B/D	3258	2114	1704	1214	701
Overhead B/D	1144	410	490	513	644
Bottoms B/D	2114	1704	1214	701	72
Gap (5%—95%) °F.	45	25	45	29	41
Gap* (IBP—EP) °F.	13	—3	20	—3	31
Cold reflux ratio (R/O)	0.35	0.98	0.92	1.75	0.39
Internal reflux ratio (R/O)	0.51	1.70	1.65	3.96	1.13
Superficial velocity (Ft./Sec.)	2.08	1.89	2.08	4.27	2.28
Top vapor load (% Brown Souders)	96	94	102.5	194	121
Bottom vapor load % Brown Souders)	165	33	116	254	116
Liquid load (GPH/in. Weir)	218	94	115	180	69
Pressure	30	5	6	8	5

* Minus sign indicates overlap.

Table III

Dimensions of Roosevelt Trays

Diameter	No. of Cascading Sections	Troughs per Section	Riser Area, Sq. Ft.	Downpour Area, Sq. Ft.	Weir Length Feet
3'-0"	2	3	0.885	1.23	4.05
4'-0"	2	5	2.02	2.14	5.52
6'-0"	4	3	3.5	5.32	16.0

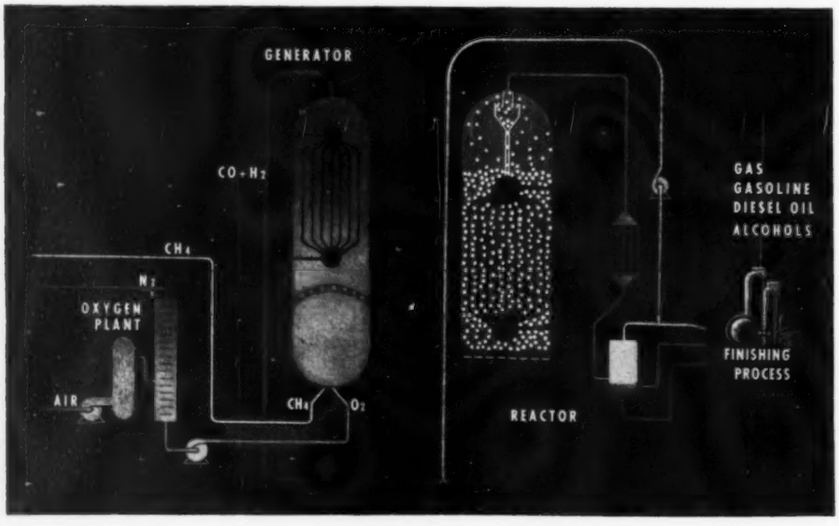
References:

1. Souders, M., and Brown, G. G., Ind. Eng. Chem. 26,98 (1934).
2. Koch, F. C., U. S. Patent 2,401,569, Apparatus for Effecting Intimate Contact Between Cases and Liquids, June 4 (1946).

SYNTHETIC OIL IS ON THE WAY

By Dr. O. W. Willcox

Drawing by Irving Geis for Standard Oil Co. (N.J.) of basic features of the Fischer-Tropsch process.



Petroleum and Coal Industries and the United States Government Are Pushing Accelerated Research into Methods of Producing Synthtic Oil. On the Following Pages World Petroleum Summarizes in Four Articles the Background and Present Status of the Search for Synthetic Oils to Supplement Petroleum.

THE year 1947 marked a turning point for the petroleum industry of the United States and ushered in a new era which will very likely be fraught with circumstances of large importance. This turning point is characterized by the fact that, for the first time in the history of this country, oil and natural gas together were supplying for all purposes including transportation

Cities Service plant at Tallant, Okla., where oxygenated chemicals have been produced from natural gas commercially for many years and where research into synthesis has been conducted.

more energy in the form of heat units than was being obtained from coal.

For the year 1948 the Bureau of Mines' first estimate of domestic consumption was 6,025,000 barrels per day, but later this was raised to 6,230,000 barrels. Domestic production in 1948 is estimated at 5,870,000 barrels per day, which is 7.6 percent greater than in 1947 and 44 percent greater than in the peak prewar year, 1941.

Authorities like Murphree of the Standard Oil Development Company find reason for believing that the annual consumption of petroleum products in this country will reach seven million barrels a day "in the next few years." Most authorities are also agreed that the domestic oil industry will find it very difficult, if not impossible, to keep production up to that level. According to Swensrud of Gulf, imports will amount to 1,000,000 barrels a day by 1955.

From the national standpoint the situation has grave implications. The pace of the world is insecure, and a third world war would impose an enormous demand for oil for military purposes. Murphree suggests that in a five-year war military operations would call for a total of 3.5 billion barrels, or approximately 690 million barrels a year.

In view of the obvious difficulty of a large expansion of domestic oil production and the uncertain prospects for large imports of foreign oil, the petroleum industry, the coal industry and the government have been giving very serious attention to the problem of synthetic liquid fuels. Each of these groups has its own reasons for being interested in the subject.

The oil men have thought it out on these lines: It is our business to supply consumers with oil products. These products will be derived from the cheapest source, which heretofore has been the domestic oil fields. It has now become more difficult for us to find enough new oil reserves to keep up with demand. There are still very great reserves of foreign oil, but to what extent the United States will be allowed to share in these reserves is uncertain.

In any case an oil company must have oil to sell. The most obvious adequate source lies in the great reserves of natural gas, oil shale and coal with which this country is endowed. To manufacture petroleum products from natural gas has been proved commercially feasible, but it is already seen that, while natural gas can make an important contribution, it will not be available for this purpose in quantities sufficient to meet foreseeable contingencies.

The last remaining recourse is coal and oil shale which fortunately are abundant enough to meet all imaginable demands for at least 1,000 years. At the present time, it is uneconomical to make petroleum products from coal and oil shale, but with demand rising and other sources declining, the picture may change, and since consumers must and will have oil products, the oil companies must be prepared to make these products from coal and oil shale.

Acting on this motive, a number of the major oil companies have already invested and are still investing large sums in research on synthetic oil from coal and shale. In the last two or three years the major oil companies have spent about $30 million of their own money on such research and are spending about $10 million more a year for this purpose.

Rather oddly but quite logically, the coal industry is also showing a deep interest in synthetic liquid fuels from coal. Petroleum fuels have made serious inroads on the coal market; coal is being eased out of its traditional uses to such an extent that coal mining interests have begun to reconsider their traditions. Present methods of handling and marketing coal are obviously out of date in this streamlined age. Whereas petroleum is refined and re-refined to give the consumer the last measure of utility and convenience, coal reaches the consumer with no more refinement than a grading according to size of lumps, and the consumer has to pay large costs for rail and truck transport and ash disposal. But it is known that coal has values that may be developed by a suitable refining process. It can be converted at the mine mouth into gas which can be converted into petroleum products by the same means that are used to convert natural gas into synthetic oil and chemical products. If liquid fuels are ever to be produced from coal, the coal companies, so they say, should obviously be among the ones to do it; and if it can be done cheaply enough, the coal industry may contend with the petroleum industry on something like equal terms.

Certain large coal interests are making heavy investment in research to develop "a coal refining industry." It is interesting to note that this effort of the coal industry is being aided by certain large petroleum interests who are participating in the expectation that the two industries will eventually find a base for fruitful collaboration.

Whether the oil and coal industries ever actually produce synthetic liquid fuels from non-petroleum sources will depend on whether they can sell the synthetic product at a profit. But the government, having in mind the international situation and a contingent sudden need for huge quantities of oil that must be had at once, is deeply interested in preparations for its production on a grand scale, profit or no profit. Congress has appropriated and the Bureau of Mines is spending millions of dollars working out methods and gaining experience in the manufacture of synthetic liquid fuels that can be put to immediate use when the time comes.

From the accompanying articles discussing oil from gas, from coal and from shale, it may be concluded that the problem of synthetic liquid fuels has been advanced to a point where the United States is assured of supplies from its own resources adequate for any scale of civilian and military consumption. Once the required facilities have been provided, synthetic oil from coal and oil shale can be had at little or no more expense than from domestic natural petroleum, and certainly for less than it cost the Germans in labor and materials. The immediate problem is the provision of these facilities, and here two formidable obstacles stand in the way. One is time; the other is the physical magnitude of the task of producing two million barrels per day of synthetic oil, which is the estimated amount needed to meet the near-future needs, including emergencies, of this country. Supposing that 500,000 barrels per day are to come from natural gas, 500,000 from oil shale and 1,000,000 from coal. Murphree estimates that the capital outlay will be about $17 billion.

The building of the required number of plants would require at least five years, provided sufficient labor and materials of construction are available. About 16 million tons of steel would be required, and the United States steel industry, which is now failing to meet the demands made on it, is in no position to furnish the amount of steel that would be required by the expanded synthetic oil industry without extensive additions to its own capacity, which again requires time and more steel.

Thus the prospect is certain that, unless the production of domestic crude oil can be greatly stepped up by discovery of new and rich oil fields, the mounting demand for oil products in this country cannot be met without maintaining the inflow of foreign oil in peace and in war. For its own peacetime requirements the United States is heavily interested in the security of the road to the Near and Middle East, and even more interested in means of national defense in case that road should be blocked. From those points of view, the creation of a substantial synthetic oil industry is obviously prudent.

The factors that will delay the full blooming of a United States synthetic oil industry are shortages of materials for construction, the time required for building the plants, and the supply of capital funds. Of these three the last mentioned seems to be the least serious. Once the technical problems are solved, Congress would be very likely to vote hundreds of millions to finance at least enough plants to cover contingent military requirements. But if the technical problems were solved, it is probable that the petroleum industry, alone or in association with the coal industry, would neither ask nor need governmental assistance. Recent surveys show that the United States spent about $3 billion here and abroad on capital investments in 1947, and would have spent more if there had been no shortages; and from company reports it seems that new investment in 1948 will reach close to $4 billions. These huge investments were, of course, made in expectation of profit, and if private capital can see a profit in synthetic oil, the plants needed for supplying the country's need for oil and for assuring its security, the $9 billion global investment postulated by the Bureau of Mines for emergency plants will doubtless be forthcoming.

OIL FROM NATURAL GAS

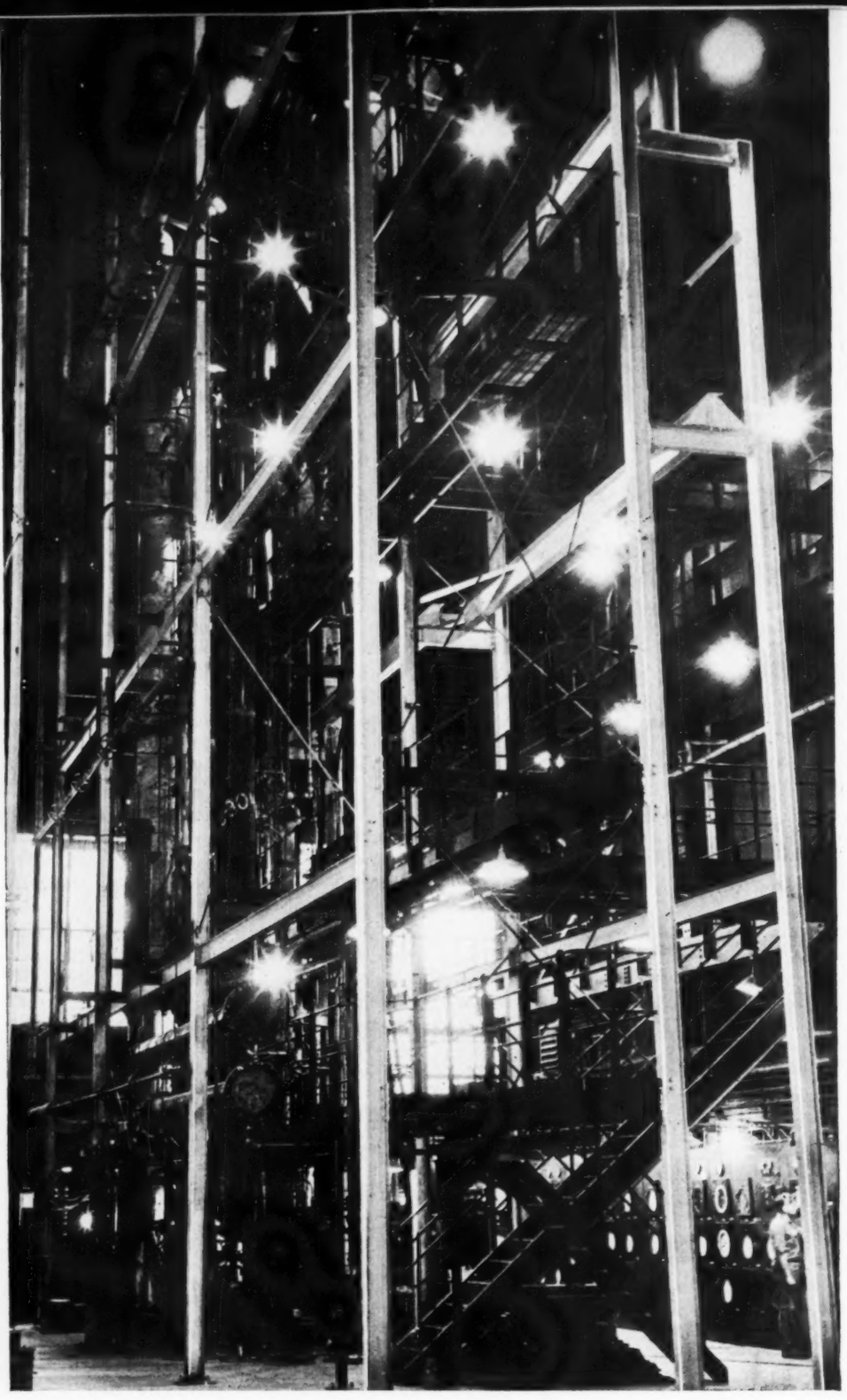
THE problem of obtaining additional supplies of oil products from natural gas on a paying commercial basis has now been answered by modern adaptations of the Fischer-Tropsch synthesis. From the practical standpoint the technology of the Fischer-Tropsch process is so far advanced that the Bureau of Mines is no longer interested in basic research on it and is confining itself to coal and oil shale, in which private industry does not yet see a profit.

Similarly a large part of the current research at pilot plants, such as that operated by Stanolind Oil & Gas Co. at Tulsa, is being devoted to methods of separating and purifying by-products of the hydrocarbon synthesis process which will be practiced at such plants as the ones building in western Kansas and south Texas. Research is continuing on the Fischer-Tropsch synthesis, it is true, but largely in the field of determining optimum flow conditions so that the commercial plant will go on stream more quickly and at maximum production, once it is completed.

The question remains as to what the new oil-from-natural-gas industry can do toward covering the expected deficit of 1,000,000 barrels daily of oil production that is now more or less clearly foreseen. (Some respectable authorities say that 2,000,000 more barrels per day will be required to meet both the growing civilian demand and the exigencies of a new world war.)

The present known reserves of natural gas in the United States are estimated at 173 trillion cubic feet, which is the equivalent of 16 billion barrels of synthetic liquid oil. There is already enough gas in sight to make oil at the rate of 1,000,000 barrels daily for 44 years. But this estimate is subject to very large discounts. In the first place a plant producing synthetic oil from natural gas should have a capacity of about 10,000 barrels daily for economical operation and would need a reserve of at least one trillion cubic feet, if it is to operate for as long as 25 years. There are not many locations in the United States where this condition is met. In view of this limitation the Bureau of Mines estimates that only about 30 trillion cubic feet of natural gas are available for conversion to synthetic liquid fuel on an economical scale. This would allow the erection of 30 plants, each with a daily capacity of 10,000 barrels per day, or a total of 300,000 barrels daily.

This estimate has also to be considered in relation to another question: Will new discoveries of natural gas continue at a rate sufficient to absorb the increasing demand for gas for its customary uses, without diminishing the usage of the quantity now considered available for synthesis? If increased demand raises the price of natural gas, the picture will be changed.

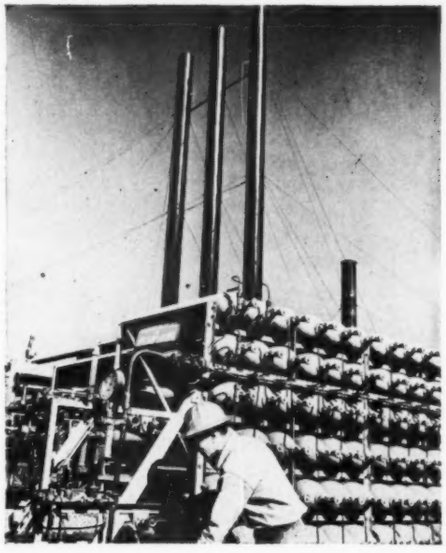


Interior view of the Synthol pilot plant of the M. W. Kellogg Co. at Jersey City, N. J. This plant, which was recently completed, embodies all the latest design developments which have been discovered by Kellogg engineers through years of research.

As regards possible new discoveries of natural gas, 13 trillion cubic feet were added to reserves in 1946, and about 14 trillion in 1947. As oil wells are drilled deeper, more gas in proportion to oil is produced, and it is estimated that new gas reserves will be found at the rate of about 10 trillion cubic feet a year for at least several years. Present users of natural gas consume 4.3 trillion cubic feet, and new pipelines that are being built or projected will increase this to 6.1 trillion. This will leave about 3.9 trillion for the synthesis plants, which could then make about 900,000 barrels daily of oil products, mostly gasoline. Even if industrial and domestic demand for gas should rise to the point of occupying half of this margin, there will still be left enough for the synthesis plants, which in any case will apparently be limited to a daily production of 300,000 barrels on account of the location problem.

General view of The Texas Company's synthesis pilot plant at Montebello, Calif. →

Bank of oxygen cylinders at the Montebello pilot plant of The Texas Company. ↓



There is still another factor that may bear on the extent to which the oil-from-gas industry may develop. This factor lies in the future of the market for oxygenated organic chemicals which are produced in considerable amounts in the Fischer-Tropsch synthesis. These chemicals now sell for good prices and are counted on to help pay for the overall operation. But the market for these chemicals is by no means as broad as the market for oil products. It has been estimated that even half a dozen 10,000-barrel synthetic oil plants would produce much more than enough of the by-products to supply the demand for oxygenated organic chemicals in the United States. This situation might develop into a serious disposal problem which could alter the assumed financial base. It is, of course, physically possible to convert some of the oxygenated chemicals into motor fuel so that the disposal problem is financial rather than physical.

The first plant to produce synthetic oil products and chemicals from natural gas will be ready for operation sometime in 1949. This plant is located at Brownsville, Texas, and will be operated by Carthage Hydrocol, Inc. The enterprise is backed mostly by The Texas Co. and Hydrocarbon Research, Inc., which are offering to license their processes to others. The Brownsville plant will have a capacity of 7,400 barrels per day of synthetic products and will consume about 80 million cubic feet of gas per day. The investment here is said to be $19 million.

A second project now taking definite shape for producing synthetic oil from natural gas will be located at Garden City, Kansas, in the Hugoton gas field. This plant will be built by Stanolind Oil and Gas Co. and is to have a nominal capacity of 6,000 barrels per day of synthetic liquid hydrocarbons and approximately 420,000 pounds per day of oxygenated hydrocarbon compounds. The process design is by Hydrocarbon Research. The investment is said to be $80 million and will involve the construction of a vast gas-gathering system.

Since the process is now an assured technological and commercial success and since there appears to be room for at least 30 10,000-barrel plants, other large interests are preparing to enter the field. One of these is Cities Service Oil Company, which is among the largest producers of natural gas in the country (154 billion cubic feet in 1947). Cities Service Co. has been doing research on the production of chemicals from natural gas and has spent "many millions of dollars" on this work. In the meantime the petroleum engineering firm of M. W. Kellogg Co. has also been doing research on the process; these two concerns have lately combined their interests in a new corporation, the Cities Service Research and Development Co., which has been operating three experimental pilot plants at Lake Charles, La., Tallant, Okla., and Jersey City, N. J. This company has not yet announced its own construction plans but is offering to license its processes.

Among other large oil companies that are known to be interested in the subject of gasoline from

Flow diagrams of the feed gas generation and synthesis reaction sections of the synthetic process.

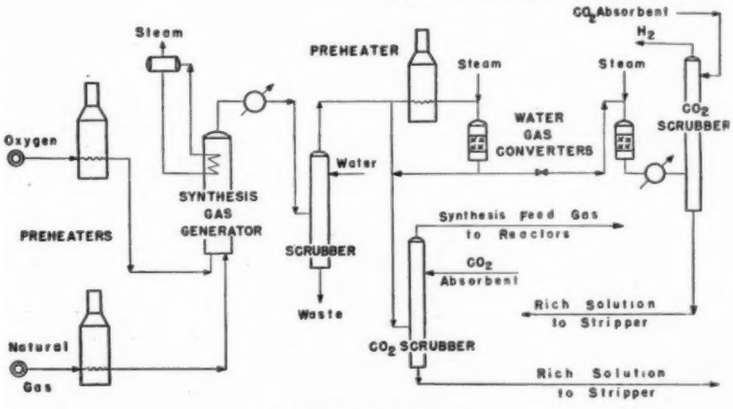


Fig. 1. Synthesis Feed Gas Generation

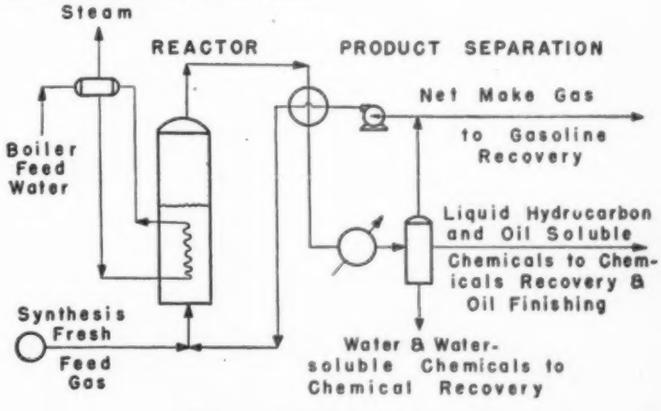
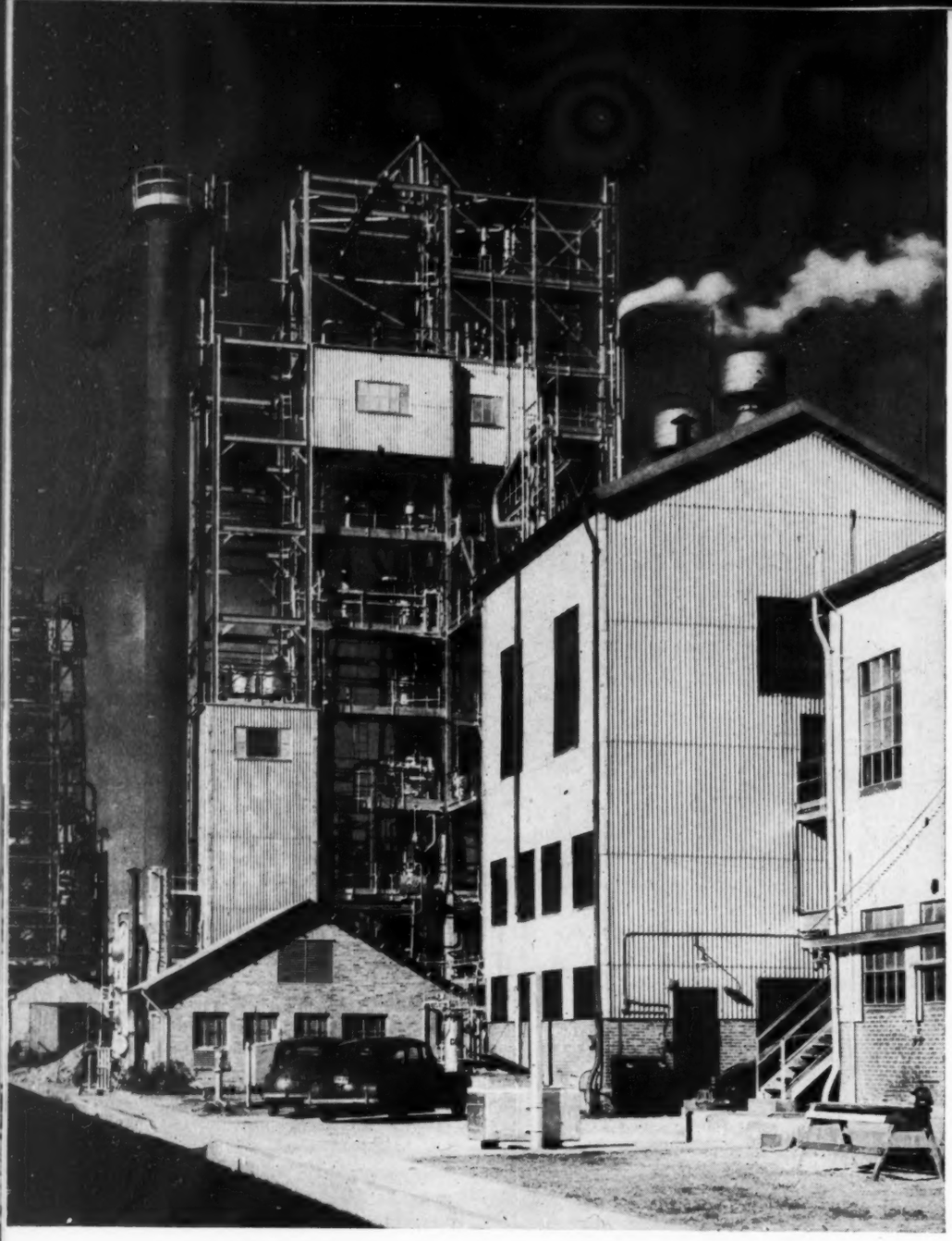

Steam
REACTOR
PRODUCT SEPARATION
Boiler Feed Water
Net Make Gas to Gasoline Recovery
Liquid Hydrocarbon and Oil Soluble Chemicals to Chemicals Recovery & Oil Finishing
Synthesis Fresh Feed Gas
Water & Water-soluble Chemicals to Chemical Recovery

Fig. 2. Synthesis Reaction Section



Esso Standard Oil Co. gas synthesis pilot plant at Baton Rouge, La. Photo by Webb.

natural gas is Standard Oil Co. (N. J.) through its subsidiary, the Standard Oil Development Co. Since the end of the late war, the Development Company has spent $10 million on development of the Fischer-Tropsch synthesis, besides large sums on oil synthesis from coal and oil shale. This company is technologically in an excellent position to enter the oil-from gas field; it has been operating Fischer-Tropsch synthesis pilot plants for a number of years and controls basic patents on the process, but so far has announced no plans for commercial plants of this kind to operate on natural gas. On the other hand, it has joined the Pittsburgh Consolidation Coal Co. in taking the first steps to what may become a stupendous project to make synthetic oil from coal.

Other oil companies which are doing pilot plant research of their own on the process at a cost which in some cases runs into "millions" of dollars include Socony-Vacuum Oil Co., Sinclair Oil Co., Gulf Research and Development Co., Shell Development Co., Sun Oil Co., Phillips Petroleum Co. and perhaps others. None of these has so far announced commercial plans.

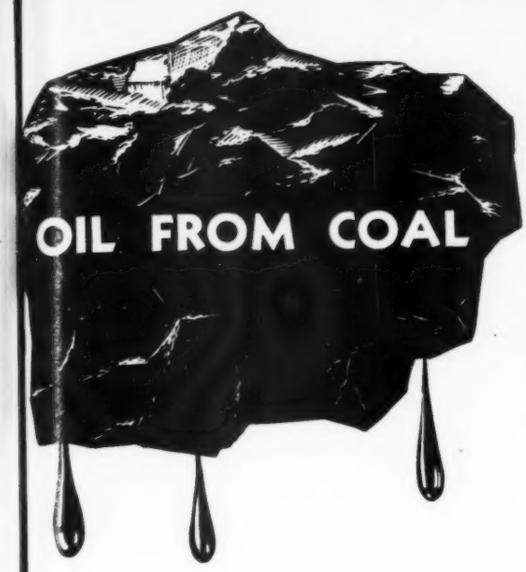
On the technical side the success of the process as applied to natural gas is due to American inventive genius which has found ways to produce cheap oxygen for use in the production of the necessary mixture of carbon monoxide and hydrogen, and especially for controlling the enormous amount of heat liberated in the process.

Among other reasons it was failure to take care of this heat that prevented the Germans from establishing an effective source of synthetic oil during the late war. They worked with an inefficient cobalt catalyst and needed 128 cumbersome reaction vessels where the American plants will use only two. The American reaction vessels are of various types; one of these employs the already familiar "fluidizing" principle that has had great success in the catalytic cracking of petroleum stocks; these vessels may be 50 feet or more in diameter and 50 feet or more in height. Working on this principle with such large units and with a cheap and highly efficient iron catalyst, it is now possible to produce gasoline from natural gas at less than a fourth of what it cost the Germans.

As described by James E. Latta and Scott W. Walker, engineers of Stanolind Oil and Gas Co., the techniques evolved for the projected hydrocarbon synthesis plant in the Hugoton gas field is shown in Figures 1 and 2. According to Fig. 1, oxygen at the rate of 53,000,000 cubic feet per day and 109,000,000 cubic feet of natural gas (previously stripped of butane and heavier hydrocarbons and containing 22 percent nitrogen,) are preheated and simultaneously supplied to a synthesis gas generator, where they are burned under a pressure of 300 pounds per square inch. The temperature of combustion is kept above 2400°F, and the natural gas is completely converted into hydrogen, carbon monoxide and carbon dioxide. No catalyst is used in this phase of the process. After combustion, the gas mixture (synthesis gas) is cooled in a waste heat recovery system where it produces steam at the rate of more than 450,000 pounds per hour. The gases leaving the generator are further cooled and purified from carbon in a first scrubber; a portion of the scrubber effluent is preheated to 600 to 700°F, steam is added, and the mixture is passed over an iron catalyst to form a mixture of carbon monoxide and hydrogen in the right proportions. Then the useless CO_2 is scrubbed out with an amine solution, the water-gas converter product is combined with the main gas stream, and the gas, now consisting primarily of hydrogen and carbon monoxide with some nitrogen, enters the fluidized-bed reactor as shown in Fig. 2, where the synthesis gas is converted into hydrocarbons and water-soluble and water unsoluble chemical products.

Although it is evident that the process has been reduced to practice, efforts are still going on to increase its efficiency. The Texas Company, which is a large participant in the Brownsville Hydrocol factory now about to begin operations, has at least a dozen pilot plant units now working on this and various other phases of synthetic oil production.

There is little doubt that if the present situation continues—that is, if the deficit in domestic crude oil production continues—if natural gas costs no more than about 10 cents per thousand cubic feet, and if the present market for gasoline and other products suffers no setback, the thirty possible synthine plants will eventually be built and operated by private capital. The road is thus open for natural gas to help in meeting the deficit of domestic crude oil production. The task is no small one; it is estimated that an oil-from-gas plant will cost about $3,500 per barrel of daily capacity, and for each barrel of daily capacity there will be needed 7.1 tons of steel. The global investment in oil from natural gas will thus amount to about $1,050 millions, and the steel requirements to 2,130,000 tons.



AMONG sources outside the petroleum industry itself to which the United States must apparently look for means to cover its increasing requirement for liquid fuels is coal. German inventors in 1911 proved that a synthetic petroleum can be made from coal and lignite, and American inventors have carried the proposition far beyond where the Germans left off.

From the standpoint of chemical technology, the steps by which petroleum may be obtained from coal are very well known, and the sole remaining problem is to conduct the process within limits imposed by current economic conditions of cost and price. This is still a large problem, but the petroleum industry and the coal industry have joined forces to make a large-scale attack on it.

The reserves of coal and lignite in the United States are enormous. It has been calculated that the quantity available for conversion to liquid fuel is about 3.2 trillion tons, equal to about 4.7 trillion barrels of gasoline, which would cover the needs of this country for several thousand years. Coal and lignite represent 98.8 percent of this country's mineral-fuel energy reserves (excluding atomic power elements). Of the remainder, petroleum proved reserves represent 0.2 percent, natural gas 0.2 percent, and shale oil 0.8 percent.

Oil companies never will be without plenty of oil to sell, provided they can make it cheaply enough from coal. On the other side, the coal companies are much interested in extracting values from their coal that will put their commodity in a better position and one that will harmonize with the interests of the oil companies.

The Standard Oil Development Company has joined the Pittsburgh Consolidation Coal Company in a major attempt to settle the question of the economical production of gas and gasoline from coal. The engineers of the two companies have completed an exploratory program of laboratory work and engineering evaluation and are proceeding with a large-scale pilot plant located at Library, Pa.

This plant will work toward two distinct but not necessarily conflicting objectives. The pilot plant now going up reflects these objectives by a combination of a coal gasification unit and a synthetic fuel unit (see diagram). The first of these units will generate a synthesis gas, and the second will convert this gas into a mixture of high Btu gas and synthetic oils. The process will use the following sequence of operations:

(1) Run of mine coal is crushed to fine sizes and conveyed to a tank for drying and blending.

(2) Coal, steam and oxygen are brought to a temperature of 2000°F in a fluidizing reaction generator, thus forming carbon monoxide and hydrogen plus a considerable amount of carbon dioxide.

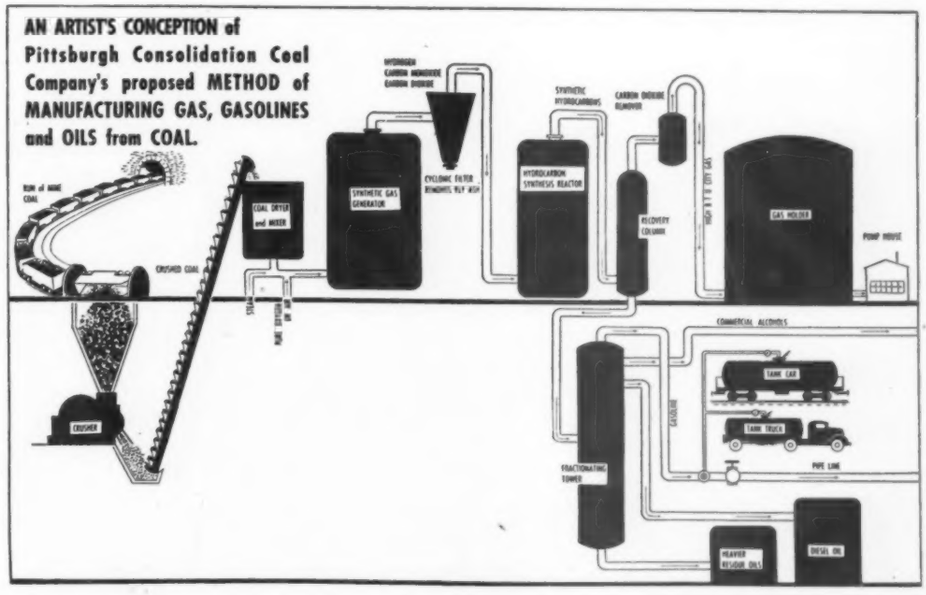
(3) The carbon monoxide and hydrogen are combined catalytically under conditions of pressure and temperature that are required to form liquid and gaseous hydrocarbons.

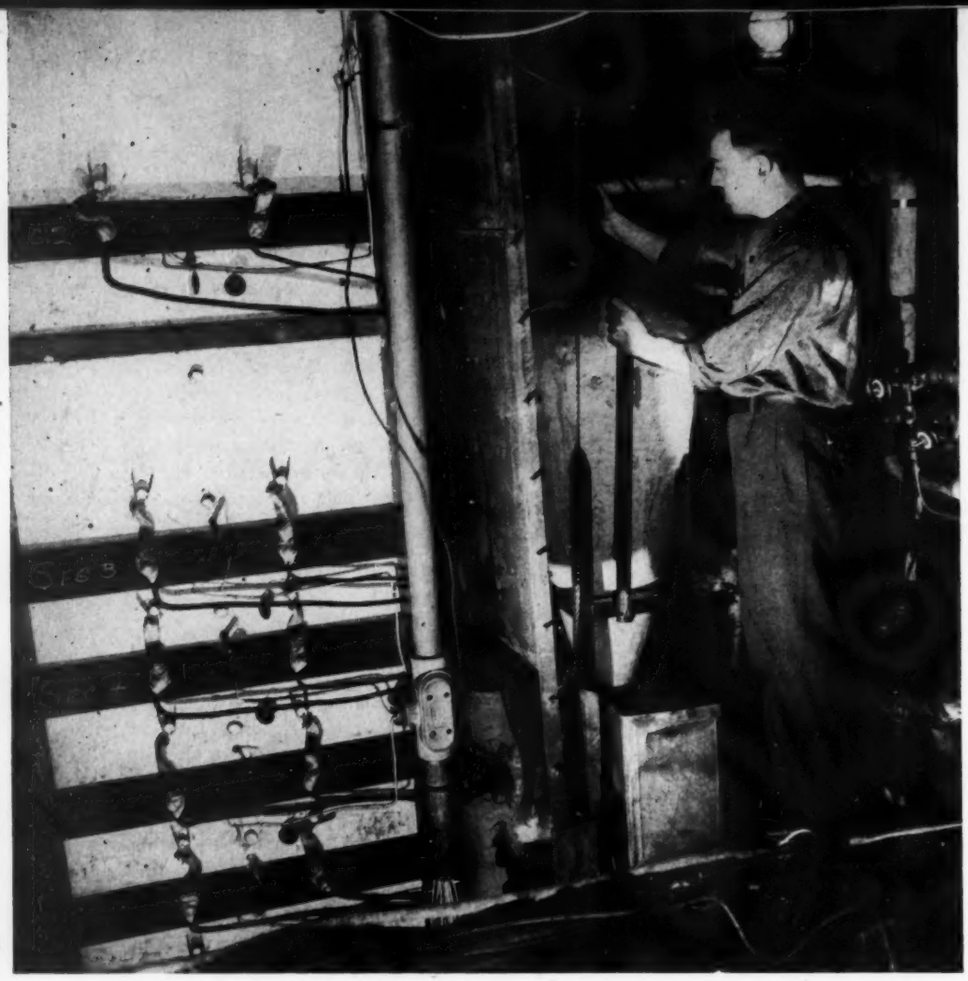
(4) These liquid and gaseous hydrocarbons are separated, the carbon dioxide is removed from the gaseous hydrocarbons, and the resulting high-calorie gas is stored in a gas holder ready for consumption. The liquid hydrocarbons are separated in a fractionating tower, giving gasoline, alcohol and other oxygenated products, diesel oil and a small quantity of heavy residue oils. The joint result is that the coal company has gas and the oil company has oil to supply their respective customers.

The fluidizing synthetic gas generator is one of the major keys to the success of the process of oil from coal. The idea was borrowed from the practice of catalytic oil cracking. In a catalytic oil cracker a finely powdered catalyst is kept suspended in an upward-moving stream of hot oil vapors; the catalyst and oil vapors come into very intimate contact, and the large oil molecules are broken down to the size of gasoline molecules. On exactly the same principle finely powdered coal and an appropriate finely powdered catalyst are suspended in a rising current of steam and oxygen, which are combined to form the gas from which synthetic oil is made. This method of gasifying the coal makes it extremely convenient to perform the operation in very large vessels and to control the generation of heat. These are features that were unknown to the Germans during the late war.

The production of gas from coal and its conversion into synthetic oil products represents the principal interest that the Standard Oil Development Company has in the project. The Pittsburgh Consolidation Coal Company has other, but not conflicting, interests; it has reached a conclusion that the coal industry must and can improve the preparation of its products for marketing. The marketing of coal in lumps is costly to all concerned. Consumers want coal of low ash content, which necessitates the operation of expensive cleaning and preparation plants. Among other things the coal industry needs a better coal refining process and a way to sell its product in its most convenient form. The most ideal of all fuels for stationary heating units is a rich gas supplied from a pipeline, and an efficient gas-generating plant is the most logical form a coal refinery can take. Since high-ash coal (up to 30 percent ash,) can be gasified by the fluidizing method, there is not only no need for expensive coal cleaning and preparation equipment, but it becomes possible to use easily mined coal deposits that are not otherwise fit for exploitation.

Another motive that has induced this coal company to throw large resources into synthetic oil research is the seasonal nature of the market for gas, whether natural or manufactured. The peak demand comes in the three winter months, when consumption often runs ahead of supply, and during the rest of the year the gas-producing facilities operate below capacity. The manufactured gas industry would be in a better position if it could find off-season use for its equipment in the production of synthesis gas for conversion into gasoline and fuel oil. Here is where coal interests and petroleum interests dovetail. There is, apparently, no reason to doubt the future of



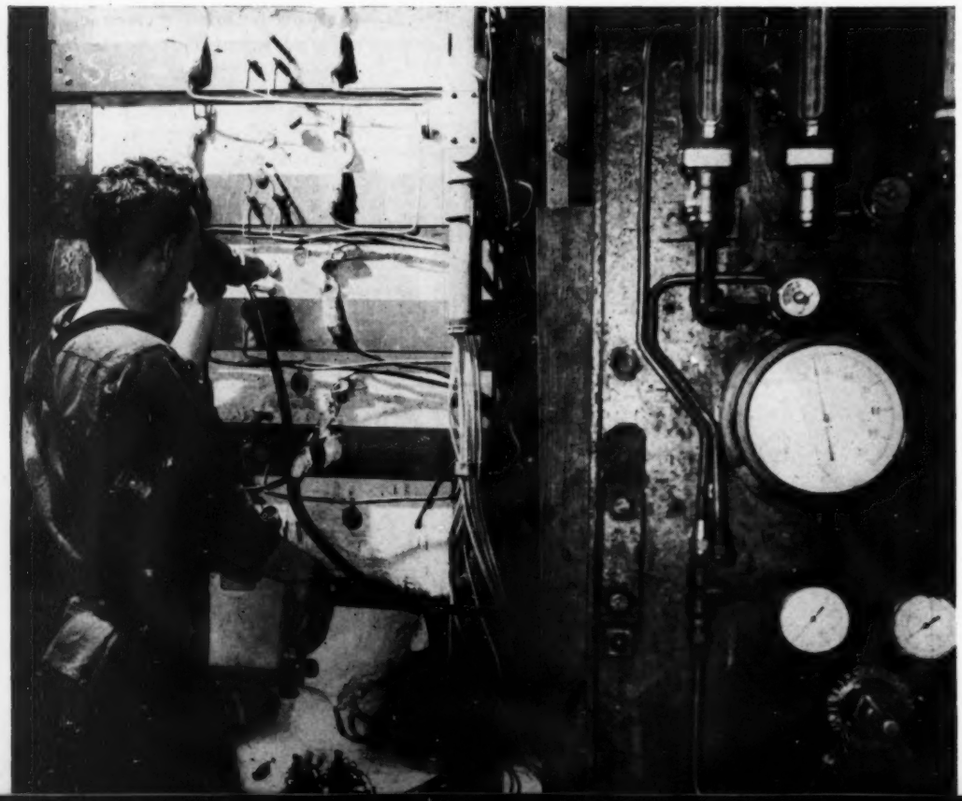


Charging pulverized coal into the feed hopper of the hydrocarbon synthesis pilot plant of Standard Oil Co. (N.J.) at Linden, N. J. Photo by Bubley.

gas as a domestic and industrial fuel, if it can be produced cheaply enough; the actual and potential demand is great, and it seems that pipelines from the natural gas fields cannot be built fast enough. Once a large supply of high-calorie manufactured gas is available, there is no reason why it may not be distributed by pipeline

The success or failure of an oil-from-coal project will depend on factors outside the plant where the actual conversion of the coal to oil takes place. The coal must be mined, transported to the coal refinery, reduced to powder and delivered to the hopper that feeds the synthetic gas generator. From there on, the process of oil from coal is

Optical check of furnace temperatures in the coal gasification pilot plant at Linden, N. J. Heat in the furnace is maintained at 1600 to 2000°F.



practically an exact parallel of oil from natural gas; from the engineering standpoint, the various steps are almost identical. In the American version of the Fischer-Tropsch synthesis, the raw material—natural gas—is converted into carbon monoxide and hydrogen by a finely powdered catalyst, using the fluidizing technique. In the new conception of a coal refinery, the raw material—finely powdered coal—is mixed with a finely powdered catalyst and converted into the same mixture of carbon monoxide and hydrogen by the same fluidizing technique. The financial feasibility of manufacturing gasoline from natural gas, which starts with the operation of producing a synthesis gas, has been amply demonstrated. The financial feasibility of manufacturing gasoline by a practically identical operation with coal can almost be taken for granted. The only trouble that could arise would be due to the presence of coal ash and sulfur in the gas generator, and from all appearances this circumstance will not have much influence on costs.

The pilot plant at Library needs to settle only such questions as reaction time, temperature, pressure and gas velocities, how to prepare the coal for the operation, how to charge it into the reactors, how to recover the gases and by-products and how to separate the sulfur and the ash. It is hardly to be expected that these matters will create much more difficulty than in the parallel operations with natural gas. These problems will be the special care of the oil technologists brought into the project by the Standard Oil Development Company. The factors that will really determine the cost of oil from coal will be found at the coal mine, and between the mine and the gates of the coal refinery. It will devolve on the coal mining engineers to see that coal is delivered to the coal refinery at a cost no greater than the cost of delivering an equivalent amount of natural gas to the hydrocarbon-synthesis factories at Brownsville or Garden City, for example. The high officials of the Pittsburgh Consolidation Coal Company have expressed a firm opinion that this can be done. Out of their large holdings they have set aside adequate reserves at selected sites and are testing entirely new mining machinery to produce safely and at low cost the special form of coal required by a synthetic oil plant. If it should transpire that oil from coal cannot compete at present costs and prices, the coal company will at least be ready if and when the economic pictures changes.

If the pilot plant at Library turns out successfully, the Pittsburgh Consolidation-Standard Oil cooperative venture is expected eventually to lead to the establishment of a $120-million commercial coal-gasification plant in the Pittsburgh district. When completed, this plant is expected to utilize millions of tons of coal which cannot be mined and shipped economically under present conditions and, according to estimates, will turn out 1,200,000 to 1,400,000 barrels of liquid fuels a day, or 100 to 400 million cubic feet of heating gases according to seasonal demands.

The joint interest of the petroleum and coal industries in oil from coal is again shown by a recently-announced agreement between the Gulf

Oil Corporation and Koppers Company, Inc., for cooperative research and development of processes for the conversion of coal to gas and liquid fuels. A forthcoming result of this cooperation will be the erection of a pilot plant, also in the Pittsburgh district.

Other oil companies are known to be interested in various degrees in oil from coal. The Texas Company has completed a new research center and pilot plants at Montebello, California, where, besides work on the Synthine process applied to heavy fuel oils, work is being done on the conversion of various types of coal to oil.

While the Bureau of Mines is carrying out its work on oil from coal in its plants at Louisiana, Missouri, and its great new laboratory at Bruceton, Pa., it is keeping alive its project on the underground gasification of coal. The results of a first experiment on a coal seam at Gargas, Alabama, have now been analyzed, and both the Bureau and the Alabama Power Co., which cooperated in the enterprise, are of the opinion that the experiment was justified and warrants a new trial on an expanded scale.

The Bureau of Mines announced on June 22 that it had signed a $411,000 contract with Alabama Power Co. for the second experiment. Alabama Power will contribute a 300-acre tract containing a 40-inch coal seam with a 100-foot overburden, and will provide engineering and operating services on an actual cost basis. Plan is to use higher temperatures and pressures to more than double Btu value of the gas produced. This trial is expected to settle the question of how much coal can be recovered in usable gas and whether the method will burn out the coal.

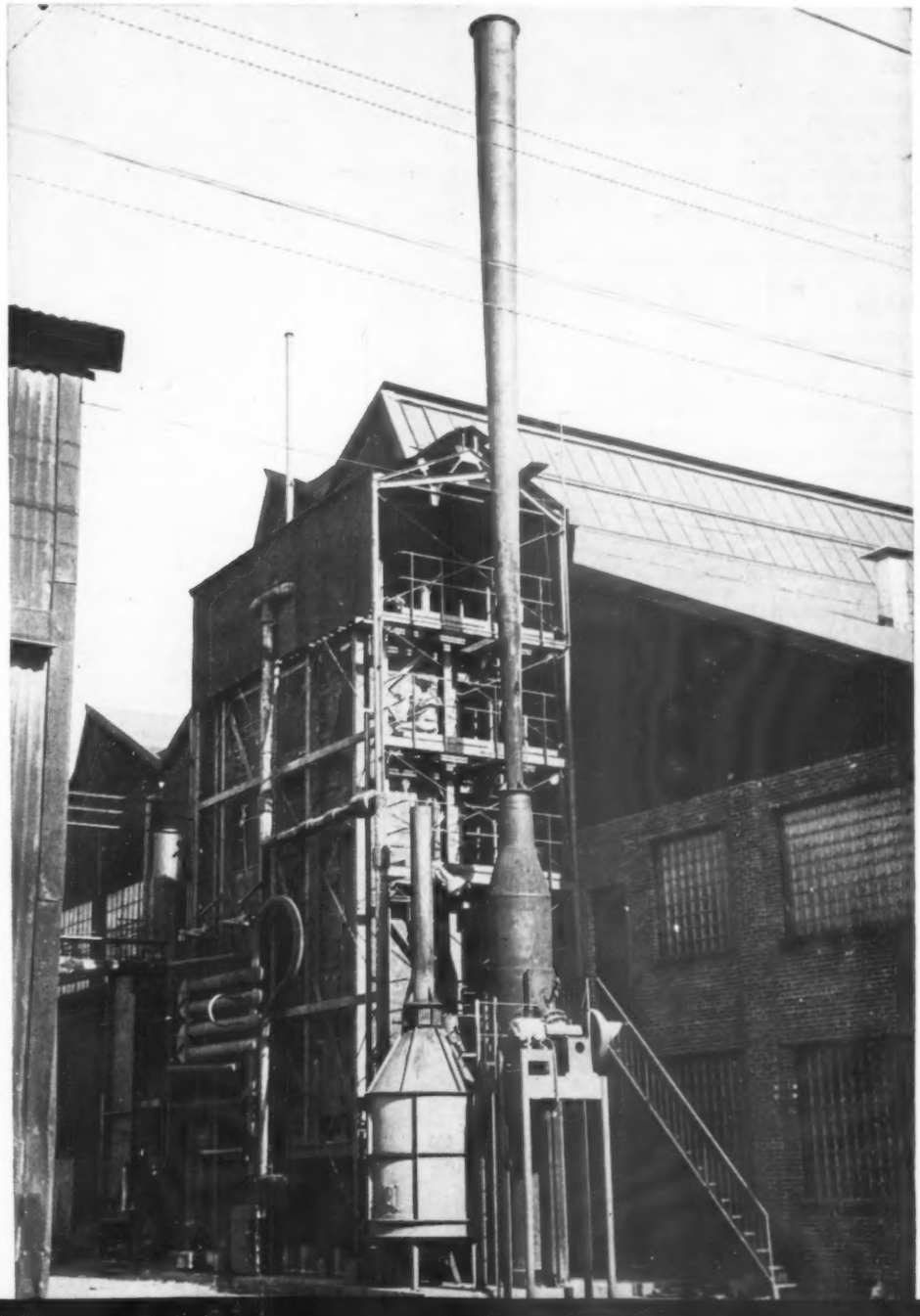
Accumulated experience here and in Russia indicate that with a cheap supply of manufactured oxygen, it is possible to produce from the coal seam itself a rich gas suitable for making synthetic oil. The use of manufactured oxygen for the underground gasification of coal has its parallel in the use of oxygen in the conversion of natural gas in Synthine plants and in the gasification of coal for the same purpose in the numerous pilot plants now operating or building. If the Gargas project gives the desired answer, the economic problem of oil from coal would be settled beyond doubt.

At the present time the major project undertaken by the Bureau of Mines, which is executing the government's program, is a $10,000,000-demonstration plant for producing synthetic oil by the direct hydrogenation of coal. This plant, which is located at Louisiana, Missouri, is designed to produce about 200 to 400 barrels of oil a day, depending on the kind of coal used. The process to be used in this plant is based on the Bergius process, which was the main reliance of the Germans for synthetic oil during the war. This process is notoriously the most expensive of all methods for producing synthetic oil, and not a single oil or coal company is now showing any interest in it. However, the Bureau of Mines has some hope of bringing it within the range of practicality by introducing some improvement over the German methods, consisting of automatic instead of hand control to give greater throughput and trouble-free operation; but the use of plant gases and direct gasification of coal to furnish hydrogen instead of the process of making it from coke, and on a more highly efficient recovery of heat. If the major portion of this work is successful, the thermal efficiency of the hydrogenation process will be raised from the 30 percent attained in the German plants to more than 50 percent, which should make quite a difference. In the meantime further work on improvement of the Bergius process is going on at the Bureau of Mines' new $3,500,000 synthetic fuels laboratories and pilot plants at Bruceton, Pa. There the Bureau is working out a process for the hydrogenation of dry coal without having to mix it with an oil medium to make a paste, as the Germans did. It is further expected that catalysts will be found which will allow the Bergius process to operate at relatively low pressure, particularly for the production of fuel oil. The expected success of these studies should go far toward bringing major changes in the economies of coal hydrogenation.

Besides this work on coal hydrogenation, the Bureau's installation at Bruceton will carry on research and development work on production of oil from coal by the Fischer-Tropsch process. In this project an interesting departure from the fluidizing technique will be tried. The synthesis gas will be produced from powdered coal by the action of steam and oxygen, according to the fluidized technique, but instead of applying this same technique to the conversion of the synthesis gas to oil products, the engineers of the Bureau of Mines have a new idea. This is to pack the converters with a granular catalyst flooded by a hydrocarbon liquid. This differs from the current fluidized bed in that the cooling liquid, instead of being circulated in tubes as in the classic cat cracker, is in direct contact with the catalyst.

(Concluding article of this series dealing with oil from Shale will be published in an early issue of WORLD PETROLEUM.)

Exterior view of new Synthol pilot plant of the M. W. Kellogg Co. at Jersey City, N. J.



OIL REFINERIES OF THE WORLD

The tabulation below has been prepared to show the present capacities and status of oil refineries outside the United States where such information is available. No data is given on U.S.S.R. plants or on refineries in nations dominated by the Russians. Capacities are in barrels per day. Key to type of plant: S-Skimming; L-Lubricating; A-Asphalt; C-Cracking; Comp.-Complete; T-Topping.

Argentina:

Name of Company	Plant Location	Crude Capacity	Type Plant	Cracking Capacity
Cia. Petrolera Astra	C. Rivadavia	2,200	S	—
Condor	Avellaneda (B.A.)	1,300	SL	—
Diadema Argentina	Dock Sud-Avellaneda (B.A.)	14,000	SC	9,000
Ferrocarrilera de Petroleo	C. Rivadavia (Chudbut)	8,000	Comp.	2,000
General de Asfaltos	Wilde (B.A.)	500	SL	—
LA Isaura	Loma Paraguaya (B.A.)	1,600	SC	1,000
Loterro y Papini	Avellaneda (B.A.)	300	SL	—
Ragor (Ramon Gorleri)	Quilmes (B.A.)	30	SL	—
Cia. Nativa de Petroleo	Campana (B.A.)	17,500	SCLA	9,100
	Bahia Blanca	4,000	SCA	2,200
	Embarcacion	1,000	S	—
	Plaza Huincul	400	S	—
Ultramar (Socony-Texas)	Dock Sud-Avellaneda (B.A.)	6,000	Comp.	2,600
Y. P. F.	Puerto La Plata	31,000	Comp.	23,000
	San Lorenzo (Santa Fe)	10,100	SC	6,200
	Lujan de Cuyo (Mendoza)	4,000	SC	3,000
	Chachapoyas (Salta)	1,900	SC	950
	Plaza Huincul (Neuquen)	1,600	SC	570

Australia:

Commonwealth Oil Refineries, Ltd.	Laverton, Victoria	2,900	S	—
Shell Co. of Australia	Clyde	5,500	SCA	1,000
Vacuum Oil Pty. Ltd. (Standard-Vacuum)	Paisley	1,200 [1]	SLA	—
Bitumen Oil & Refineries Ltd.	Sydney	3,000	A	—

[1] Building. To be completed February, 1949.

Austria:

Anglo-American Group				
Vacuum Oil Co.	Kagran	1,940	S	—
A.G. der Shell-Floridsdorfer				
Mineraloll-Fabrik (Shell)	Floridsdorf	2,525	SLA	—
Oesterr. Mineralolwerke	Lobau	4,850	S	—
Former German Group				
Deutsche Erdol A.G.				
Erdolwerke Nova	Schwechat	3,100	SC	3,840
Deutsche Gasolin A.G.	Korneuburg	700	S	—
Benzin-Benzol-Verband	Vosendorf	1,165	S	—
Donau Oel G.M.B.H.	Moosbierbaum	2,330	S	—
German Gov't	Hauskirchen	1,540	S	—
Deutsche Erdol A.G.	Ebensee	1,860	S	—

Bahrein Island:

Bahrein Petroleum Co.	Persian Gulf	145,000	SCA	25,000

Belgium:

Belgian Shell	Langerbrugge	4,000	LSA	—
Compagnie Industrielle "Atlas" S. A.	Atlas	1,500	S	—
Raffinerie Belge de Petroles	Antwerp [1]	2,200	SC	1,000
Raffineries et Distilleries Anversoises S. A. "Radian"	Antwerp, Kiel	740	S	—
"Redeventza" S. A. Belge pour la Raffinage de Petrole	River Scheldt	2,450	SC	1,000
Tankage et Transport S. A.	Antwerp, Kiel	1,000	S	—

[1] 2000 B/D Distillation unit under construction.

Bolivia:

Yacimientas Petroliferous Fiscales Bolivianos	Sandita	500	S	—
	Camiri	500	S	—

Brazil:

Name of Company	Plant Location	Crude Capacity	Type Plant	Cracking Capacity
Industrias Matarazzo de Energia	Sao Paulo	2,500	S	—
Ipiranga S. A. Cia. Brazilena de Petroleas	Rio Grande	1,800	S	—
Consuelho Nacional do Petroleo	Bahia	500	S	—
National Pet. Refg.	Bahia State	2,500 [1]		
Refinaria de Petroleos, do Distrito Federal	Rio	10,000 [1]		

[1] Construction contracts awarded.

British Borneo:

Sarawak Oilfields, Ltd.	Lutong, Sarawak	31,000	S	—

A new refinery to replace Lutong plant will be built on Muara Island in Brunei Bay with capacity of 36,000.

Burma:

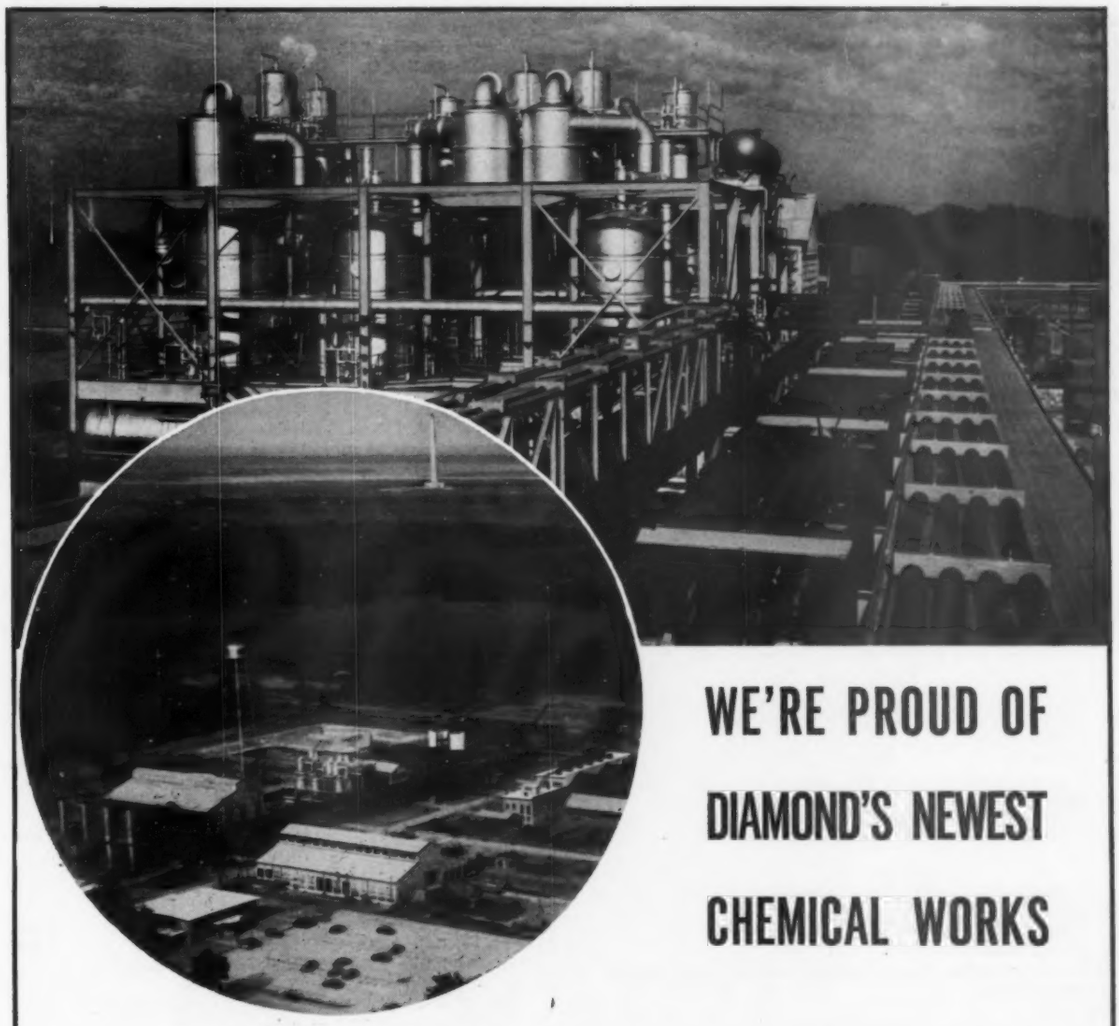
Burma Oil Co.	Rangoon	2,000	S	—

Canada:

Anglo-Canadian Oils, Ltd.	Brandon, Manitoba	1,200	SC	850
British American Oil Co., Ltd.	Montreal, East [1]	15,000	SC	7,500
	Toronto, Ontario	5,000	SC	—
	Clarkson, Ontario [2]	10,000	SL	4,400
	Moose Jaw, Saskatchewan	5,000	SC	2,000
	Calgary, Alberta	5,000	SC	2,100
Canadian Oil Companies, Ltd.	Petrolia, Ontario	7,000	SC	2,150
Excelsior Refineries, Ltd.	Lloydminster	700	S	—
Husky Oil & Ref. Co.	Lloydminster	2,500	S	—
Gas & Oil Refineries, Ltd.	Hartell, Alberta	1,250	SC	1,000
Gold Standard Oils, Ltd.	Wainwright, Alberta	300	S	—
Hi-Way Refineries, Ltd.	Moose Jaw, Sask.	300	S	—
	Saskatoon, Sask.	300	S	—
	Rosetown	300	S	—
Imperial Oil, Limited	Dartmouth, Nova Scotia	24,000	SC	8,440
	Montreal	30,000	SC	12,000
	Sarnia, Ontario	55,000	SC	27,000
	Regina, Sask.	10,500	SC	8,200
	Calgary, Alberta	10,300	SC	4,000
	Ioco, Br. Col.	12,000	SC	2,750
	Norman Wells, NW. Ter.	1,100	S	—
	Edmonton, Alberta	6,000	SC	3,000
McColl-Frontenac Oil Co., Ltd.	Montreal, East	24,000	SC	14,000
	Toronto, Ontario	12,000	SC	7,000
New Brunswick Gas & Oilfields, Ltd.	Weldon, New Br.	250	S	—
North Star Oil, Ltd.	Winnipeg, Manitoba	1,645	SC	680
Northern Petroleum Corp., Ltd.	Kamsack, Sask.	300	S	—
Radio Oil Refineries, Ltd.	East Kildonan, Manitoba	1,000	S	—
Saskatchewan Federated Cooperatives, Ltd.	Regina, Sask.	2,000	SC	800
Shell Oil Co. of Canada, Ltd.	Montreal, East	10,000	SC	7,500
Shell Oil Company of British Columbia, Ltd.	Shellburn, Br. Col.	4,000	S	—
Standard Oil Co. of British Columbia, Ltd.	Burnaby, Br. Col.	4,300	S	—
Trinidad Leaseholds	Port Credit	4,500	SC	2,600

[1] 200 B/D LPG plant completed July, 1948; 200 B/D catalytic polymerization plant to be completed summer, 1948; construction to be completed in 1949 includes 14,500 B/D crude still, 13,500 B/D fluid cat cracker; 500 B/D catalytic polymerization unit.

[2] 1000 B/D lube blending plant to be completed 1948.



WE'RE PROUD OF DIAMOND'S NEWEST CHEMICAL WORKS

Diamond Alkali Company's newest chemical plant, the Houston Works on the Houston Ship Channel, recently went on stream, manufacturing chlorine and caustic for what it's able young president, R. F. Evans, so aptly described as "the living, growing, expanding chemical industry." Brown & Root, Inc. are proud to have been selected for engineering and construction of this great plant—proud of the part we have in the process industry in the Southwest, which is fast securing its position as a world chemical capital.

BROWN & ROOT, Inc.

P. O. Box 2634 Houston 1, Texas

China:

Name of Company	Plant Location	Crude Capacity	Type Plant	Cracking Capacity
Chinese Government	Yumen	2,000	S	—
	Takao, Formosa	6,000	SC	—
	Hulutao, Manchuria [1]	2,000	S	—
Manchurian Petroleum Co.	Dairen [2]	5,000	SC	2,000

[1] Formerly an alcohol plant, reported rebuilt to run oil.
[2] Capacity shown is prewar. Present unknown.

Chile:

Johannsen, C. H.	Coquimbo	125	S	—
Maritano, Miguel	Talcahuano	60	S	—
Societe Establecimientes Quimicos	Vina del Mar	175	S	—
Corp. de Fomento	Santiago [1]	10,000	SC	—

[1] Planned for completion in 1950.

Cuba:

Cia. Exploradora de Petroleo	Jarahuoca	365	S	—
Standard Oil Co. of Cuba	Belot	4,000	SCLA	1,100
Cia. Petrolera Jarahuoca	Jarahuoca	320	S	—
Cuban Oil Ref. Co.	Cabaiguan	800	SC	650
Union Gas Co.	Bacaranao	285	S	—

Colombia:

Colombia Petroleum Co.	Petrolea	500	S	—
Tropical Oil Co.	Barranca Bermejo	22,700	SLA	—

Denmark:

AA/S Kalundborg Olieraffinaderi	Kalundborg	500	A	—

Eucador:

Anglo Ecuadorian Oilfields, Ltd.	La Libertad	2,800 [1]	S	—
Ecuador Oilfields, Ltd.	Cautivo	700	S	—

[1] To be increased to 4,000 B/D 1948.

Egypt:

Anglo Egyptian Oil Fields, Ltd.	Suez	40,000	TCASC	7,000
Refinnerie de Petrole du Government	Suez	2,000	SA	—

Plans for new units in existing plants
Anglo-Egyptian Shell-Suez—Conversion of gasoline rerun unit to crude topping 14,000 b/d. Comp. expected end 1948.
Under construction—New plant
R.P.G.—Gov't-Suez—3,500 b/d, operation expected end 1948.

France:

Cie. Francaise de Raffinage	Normandy	32,000	Comp.	—
	Provence [1]	30,000	SC	—
Cie. Industrielle des Petroles	Frontignan [2]	1,350	SCL	—
Cie. de Reffinage Shell-Berre	Petit Couronne	6,000	SC	—
	Pauillac	3,100	S	—
	Berre [3]	16,500	SC	—
Pechelbronn S.A.E.M.	Merkwiller	1,100	SL	—
Raffineries Francaise de Petrole de l'Atlantique	Donges	7,400	S	—
Raffineries de Petroles de la Gironde	Bec-d'Ambes [4]	—	SD	—
Raffineries de la Vacuum Oil Cie.	N.D. de Gravenchon [5]	17,000	Comp.	—
Societe General des Huiles de Petrole	L'Avera	18,500	Comp.	—
	Dunquerque [6]	—	—	—
Standard Francaise des Petroles	Port Jerome [7]	30,000	SCLA	—
	La Mailleraya	500	S	—

[1] 20,000 B/D additional crude capacity and 2,500 B/D lube plant planned.
[2] New crude distillation under construction. Lube production will be discontinued in 1949 and plant operated at 13,500 B/D for black and white products.
[3] Capacity to be increased to 47,000 B/D in 1951.
[4] Plant destroyed during war; will be rebuilt to 13,000 B/D by end of 1949.
[5] Lube processing equipment now being installed.
[6] Reconstruction begun. Plant will reach 22,200 B/D capacity in 1951.
[7] New pipestill will increase capacity to 40,000 B/D by Oct. 1, 1948. Ultimate capacity expected to be 60,000 B/D by 1951.

Germany: British Zone:

Name of Company	Plant Location	Crude Capacity	Type Plant	Cracking Capacity
Deutsche-Amerikanische Petroleum Gesellschaft (SONJ) Ebano Asphalt-Werke	Hamburg-Harburg [1]	2,600	A	—
Deurag-Nerag Misburg Refinery	Misburg	10,000	Comp.	2,400
Deutsche Gasolin A.G.	Dollbergen	2,000	Comp.	—
Deutsche Shell A.G.	Hamburg-Harburg [2]	—	—	—
	Reisholz	900	S	—
	Hamburg-Grasbrook	1,300	L	—
	Hamburg-Wilhelmsburg	470	S	—
Mineraloelwerke Albrecht & Co. (Shell)	near Hamburg	230	L	—
Shell Group & Union Rheinische — Braunkohlen Kraftstoff Aktiengesellschaft	Wesseling	3,350	Hydrog.	—
	Gelsenberg	6,700	Hydrog.	—
Deutsche Vacuum Oel A.G. (Socony-Vacuum)	Schlau-Hamburg	700	Comp.	—
British Crusader Petroleum Industries, Ltd. Eurotank Refinery	Hamburg-Finkenwerder [3]	3,500	SC	2,800
Mineraloel & Asphalt-Werke	Ostermoor	2,400	SA	—
Deutsche Erdoel A.G.	Heide	2,400	S	—
	Wietze	1,200	Comp.	—
Mineraloelwerke Peine	Peine (nr. Hanover)	600	SL	—
Greiser	Dollbergen	300	S	—
Schindler	Hamburg	720	Comp.	—
Wintershall A.G.	Salzbergen	1,200	Comp.	420
Johann Haltermann	Hamburg	1,200	S	—

[1] Anticipated runs: 1950, 14,000 B/D; 1951, 23,000 B/D.
[2] Destroyed; will be rebuilt in 1950 to 7,200 B/D capacity.
[3] Building to 5,800 B/D.

Germany: Russian Zone:

Wintershall A.G.	Luetzkendorf refinery, nr. Leipzig	—	—	—

Also hydrogenation and Fischer-Tropsch plants.

Germany: French Zone:

Badische Anilin & Soda Fabrik (formerly I. G. Farben Industrie)	Ludwigschafen-Opau	600	Comp.	—

Germany: American Zone:

Deutsche Vacuum Oil A.G. (Socony-Vacuum)	Bremen-Oslebshausen [1]	3,200	L	—
Deutsche Shell A.G.	Monheim	1,450	SLA	—
Zeller & Gmelin	Eislinger-Wuertemberg [2]	—	—	—

[1] Building additional 9,500 B/D skimming capacity.
[2] Building to 300 B/D capacity.

Hungary:

Molaj Magyar Szovjet Olajmuvek R.T.	Szony	7,600	S	—
Vacuum Oil Co. R.T.	Almasfuzito	4,600	Comp.	—
Magyar Petroleumipar R.T.	Budapest	760	Comp.	—
Peti Nitrogenmuvek R.T.	Petfurdo	4,900	Comp.	—
Shell Koolaj R.T.	Csepel	4,900	Comp.	—
Fanto Egyesult Magyar Asvanyolajgyrak R.T.	Gyovar } Budapest }	365	Comp.	—
Nyirbogdanyi Petroleumgyar R.T.	Nyirbogdanyi	1,400	Comp.	—
Szoregi Petroleumgyar R.T.	Szoregi	300	Comp.	—

India:

Assam Oil Co.	Digboi	6,000	S	—

Iran:

Anglo-Iranian	Abadan	420,000	SC	—
Anglo-Iranian	Kerminshah	2,100	S	—
Anglo-Iranian	MIS	70,000 [1]	Cr.	—

[1] Crude topping plant for Abadan refinery makes no finished products, ships tops or bottoms to Abadan by P. L. as required for finishing.

Iraq:

Iraq Petroleum Co.	Baba Gurgur	1,500	S	—
Kanaquin Oil Co., Ltd. (Anglo-Iranian)	Alwand	6,900	S	—

Government of Iraq plans to build a 1,000 B/D plant at Baiji.

On the Beam...

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AEROLUBE** ADDITIVES...for highest quality Regular, Premium, Heavy-Duty Motor Oils

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Petroleum Chemicals Department
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Italy:

Name of Company	Plant Location	Crude Capacity	Type Plant	Cracking Capacity
A.N.I.C.	Leghorn	4,500	SC	4,000
A.N.I.C.	Bari [1]	5,000	SC	2,000
Azienda Generale Italiana Petroli (AGIP)	Savona	400	S	—
	Venice	5,800	SC	2,000
Distillazione Italiana Combustibili S.A. (DISCA)	Marghera (Venice)	5,000	SC	3,500
RaRaffineria di Napoli S.A.I. (Socony-Vacuum)	Naples [2]	9,000	S	—
Societa per la Industria Italiana del Petrolio (Nafta)	La Spezia	6,000	SC	2,800
Societa Petrolifera Italiana	Fornovo Taro (Parma)	300	S	—

[1] Hydrogenation plant.
[2] To be increased to 16,000 B/D by mid-1949.

Japan:

Before the war Japanese refineries had a combined capacity of 113,000 barrels daily of crude and a cracking capacity of 41,000 barrels daily. This was largely destroyed. Currently Japanese plants on the West Coast have a capacity of about 4,000 barrels daily and are running indigenous crude. East Coast plants are being rebuilt to a capacity of about 5,000 barrels daily but this will not be ready for operation before 1949.

Korea:

Russian Government	Genzan (Wansun)	5,000	S	—

Mexico:

Pemex—Arbol Grande	Tampico	19,500	SLA	—
" —Bella Vista	Tampico	4,700	SC	1,200
" —Cuidad Madero	Tampico	51,500	Comp.	5,000
" —Villa Cuauhtemoe	Veracruz	13,400	SC	9,300
" —18 de Marzo	Mexico City	50,000	SC	13,000
" —Mata Redonda	Tampico	20,000	SC	7,000
" —Minatitlan	Minatitlan	27,200	SL	—
" —Poza Rica	Poza Rica	6,400	S	—
"	Nuevo Laredo	330	S	—
"	Monterey	160	S	—
"	Juarez	1,000	S	—

Netherlands:

N.V. Bataafsche Petroleum Mij. (Shell)	Rotterdam [1]	20,000	Comp.	12,000
Caltex Petroleum Mij. N.V.	Pernis (Rotterdam) [2]	20,000	Comp.	6,400

[1] To be increased to 75,000 B/D within five years.
[2] Building; expected to be completed early 1950.

Netherlands East Indies:

N.V. de Bataafsche Petroleum Mij. (Shell)	Balikpapan, N.E. Borneo	10,000	Comp.	—
	Pangkalan Brandan, Sumatra [1]	23,000	—	—
	Pladjoe, Sumatra	52,700	SCL	8,000
	Tjepoe, Java [1]	15,000	SCW	3,000
	Wonokromo, Java	1,200	SA	—
N.V. Standard Vacuum Petroleum Mij.	Palembang, Sumatra	45,000	Comp.	20,000

[1] Shut down, plant condition unknown.

Netherlands West Indies:

Lago Oil & Transport Co.	Aruba	390,000	SCA	300,000
Curacaosche Petroleum Industrie Mij.	Curacao	235,000	SC	100,000
Arend Petroleum Mij.	Aruba [1]	31,500	SC	3,000

[1] Dubbs unit converted to distilling unit.

Pakistan:

Attock Oil Co.	Punjab, Rawahlpindi	4,000	SC	2,000

Poland*

All Refineries Under "Central Management of the Liquid Fuel Industry," "United Petroleum and Natural Gas Industries" Branch:

Czechowice Refinery	4,000 crude	Comp.	—
Trzebina Refinery	6,500 "	SL	—
Jaslo Refinery	1,200 "	SL	—
Glinik Refinery	1,500 "	Comp.	—
Jedlicze Refinery	1,100 "	SL	—
Ligota Refinery	250 "	SL	—

Palestine:

Name of Company	Plant Location	Crude Capacity	Type Plant	Cracking Capacity
Consolidated Refineries	Haifa [1]	85,000	SCA	35,000

[1] Shut down because of political disturbances. Planned to erect new 60,000 D/B unit; before political disturbances, completion estimated late 1948.

Peru:

International Petroleum Co.	Talara	28,000	Comp.	7,100
Cia. de Petroleo Ganzo Azul, Ltda.	Aguas Calientes	500	S	—
Establecimiento Ind. de Pet. de Zorritos	Zorritos	1,000	S	—

Portugal:

"Sacoy" S.A. Concessionaria da Rafinaco de Petroles em Portugal	Lisbon	5,000	SL	—

Romania:

Refining properties of American and European oil companies have been taken over by the government, and little is currently known about the extent to which war damage has been repaired .

"Astra Romana" S. A.	Ploesti-Sud	33,000	Comp.	1,100
"Colombia" Societe Franco Roumaine de Petrole	Ploesti-Sud	10,000	Comp.	4,800
Concordia Vega S. A. Roumaine pour l'Industria du Petrole	Ploesti-Nord	20,000	Comp.	4,200
"Creditul Miniere" S.A.R. Pentru Desvoltarea Industriei Miniere	Brabi-Prahova	5,500	Comp.	2,400
Dacia Romana Petroleum Syndicate, Ltd.	Ploesti [1]	2,700	S	—
Neo Petrole Fratia	Ploesti-Sud	3,200	S	—
Noris	Ploesti-Sud	1,300	S	—
"Petrole Block" S.A. Romana	Ploesti (Standard)	7,000	Comp.	3,450
"	Buzau (Saturn)	500	S	—
Petrol Latina SAR	Ploesti	3,000	S	—
"Photogen" Rafinerie de Petrol S.A. (Soc.-Vac.)	Brasov	3,500	SL	—
"Prahova" S. A. Romana (Petrol Bucuresti)	Bucarest [1]	3,500	Comp	
Rafinaria de Petrol "Titan"	Bucarest-Cioplea [1]	900	S	—
Romano-Americana S. A. pour l'Industrie, le Commerce et l'Exportation du Petrole	Teleajen (nr. Ploesti)	18,000	Comp.	8,000
Romano-Belgiana de Petrol "Venus"	Sarat	900	S	—
Soc. Generala M & P	Doicesti-Dambovita	1,500	S	—
"Steaua Romana" S. A. pour l'Industrie de Petrole	Moinesti	1,050	S	—
"	Campina	12,000	Comp.	—
"Unirea" S. A. Romana de Petrole	Ploesti (2 plants) [1]	8,600	Comp.	—
"Xenia" S. A. (Sov-Ro-M Petrol)	Ploesti-Nord	4,600	S	3,000

[1] Ordered shut down in accordance with government program of integration of operations.

Saudi Arabia:

Arabian American Oil Co.	Ras Tanura	130,000	S	—

Siam:

Siamese government plant at Bangkok has been dismantled.

Sweden:

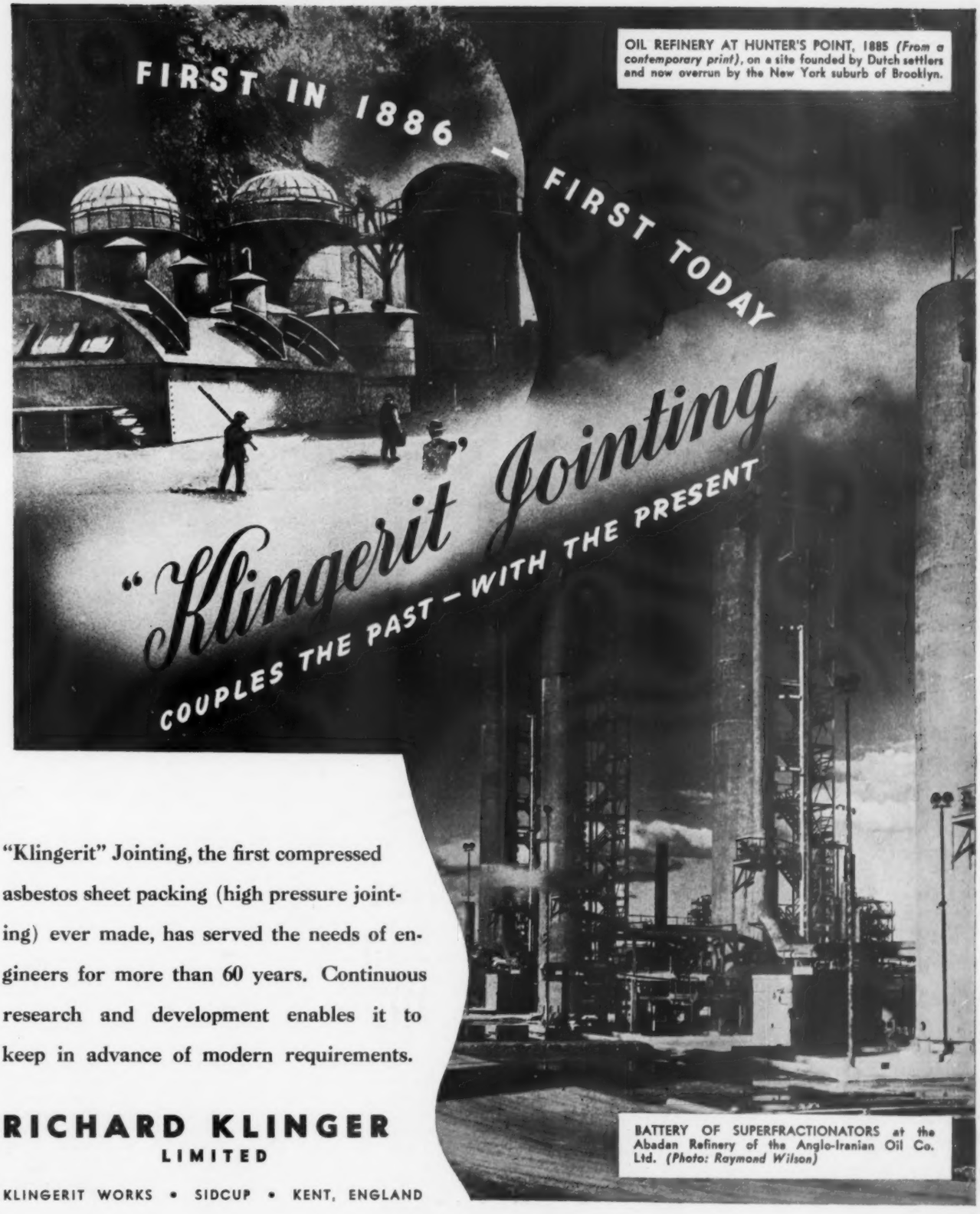
Johnson & Co., A.	Nynashamm	10,000	Comp.	2,300
	Malmo	1,000	A	—
Stora Kopperberg, Inc.-Transatlantic	Goteborg [1]	10,000	SC	—

[1] Building; may be in operation by July, 1948.

Syria:

Iraq Petroleum Co.	Tripoli [1]	5,500	S	—

[1] To be increased to 10,000 B/D in 1949.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OIL REFINERY AT HUNTER'S POINT, 1885 (From a contemporary print), on a site founded by Dutch settlers and now overrun by the New York suburb of Brooklyn.
BATTERY OF SUPERFRACTIONATORS at the Abadan Refinery of the Anglo-Iranian Oil Co. Ltd. (Photo: Raymond Wilson)

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AGENTS FOR CANADA: *The Canadian Asbestos Company, 316-322 Youville Square, Montreal.*

Spain:

"Campsa" Cia. Arrandatarin del Monopolio de Petroleo, S. A.	Barcelona [1]	600	SL	—
"Cepsa" Cia. Espanola de Petroleo S. A.	Canary Is.[2]	12,000	SC	5,000

[1] Shut down.
[2] To be increased to 18,000 B/D.

Switzerland:

Ispa A. G.[1]	Rotkreuz	1,500	S	—

[1] Omnium Francaise reported to own controlling interest.

Trieste:

Aquilla (Redeventza)	Trieste	7,000	SL	—
Soc. Italo Americano Petrado (SIAP)	Trieste	2,500	SLA	—

Venezuela:

British Controlled Oilfields	El Mene	250	S	—
Caribbean Petroleum	San Lorenzo	38,000	S	—
Colon Development Co., Ltd. (SHELL)	Casigua	1,500	S	—
	La Rivera	200	S	—
	El Cavario	200	S	—
	Punta Cardon [1]	50,000	SC	—
Creole Petroleum Co.	La Salina [4]	10,000	SA	—
	Amuay Bay [1]	60,000	SCLS	—
	Caripito	55,000	SC	24,000
Mene Grande Oil Co.	Cabimas	1,800	S	—
	Cabimas [3]	10,000	S	—
	Oficina	420	S	—
Tocuyo Oilfields of Venezuela, Ltd.	El Mene [3]	250	S	—
Texas Petroleum Co.	Tucupita	10,000	S	—

[1] Building.
[3] Heavy crude processing plant, manufactures fuel oil.
[3] Shut down.
[4] Heavy crude process plant 20,000 b/d on 110° Flash crude.

U. S. S. R.:

Before the war there were 13 refineries in Soviet Russia with a crude capacity of 637,500 barrels daily and a cracking capacity of 178,500 barrels daily. The Government has not announced a list since the war.

Trinidad:

Kern Trinidad Oilfields	Trinidad	1,000	S	—
Trinidad Leaseholds, Ltd.	Pointe-a-Pierre	50,000	Comp.	40,000
United British Oilfields	Point Fortin	40,000	SA	—
Trinidad Lake Asphalt Operating Co.	Brighton	1,000	A	—
Trinidad Oil Fields Operating Co., Ltd.	Port of Spain	1,300	S	—

Uruguay:

Administration Nacional de Combustibles, Alcohol y Portland (ANCAP)	Montevideo [1]	8,000	SC	2,000

[1] Capacity to be increased to 14,000.

United Kingdom:

Anglo-American Oil Co.	Fawley [1]	14,000	SLA	7,000
Berry, Wiggins & Co., Ltd (2 Plants)	Kingsnorth, Kent	1,500	SL	—
"	Weaste (nr. Manchester)	1,200	S	—
Briggs & Son, Ltd., William	Dundee	650	SL	—
Carless, Capel & Leonard	London	200	S	—
Cory Bros. & Co., Ltd.	Corydon [2]	3,000	SC	2,000
Green, Herbert & Co.	E. Halton, Lincolnshire	1,500	SL	—
Keys, W. H., Ltd.	Avonmouth	450	S	—
"	West Bromwich	350	S	—
Lobitos Oil Fields, Ltd.	Ellesmere Port	3,000	SC	1,000
London & Coastal Oil Wharves, Ltd.	Canvey Island	1,500	S	—
London & Thames Haven Oil Wharves, Ltd.	Thames Haven	10,000	SL	—
Major & Co., Ltd.	Hull	1,250	SL	—
Manchester Oil Refinery, Ltd.	Manchester	3,000	SL	—
National Oil Refineries, Ltd.	Llandarcy, So. Wales [3]	11,300	Comp.	4,000
Scottish Oils, Ltd.	Grangemouth, Scotland [4]	7,500	SC	3,000
	Uphall (Pumpherston)	2,000	SC	500
Shell Refineries, Ltd.	Androssan, Ayrshire	3,500	Comp.	—
	Shell Haven, London	13,000	Comp.	—
	Stanlow (Ellesmere Port)	13,000	Comp.	—
	Trimpel, Heysham	30,000	S	—

[1] To be expanded to 120,000 B/D.
[2] Long unused, probably not operable.
[3] Capacity to be increased to 20,000 B/D by Dec. 31, 1948.
[4] To be expanded to 12,000 B/D by Dec. 31, 1948.

Books on Synthetic Fuels

Abstracts of Current Literature on Synthetic Liquid Fuels, Vol. 1, prepared by Technical Reports Section, Synthetic Liquid Fuels Research and Development Division of the Bureau of Mines at Pittsburgh. Published 1948 by Hobart Publishing Co., Washington, D. C., mimeographed; $12.50.

This bulky volume contains more than 1,000 abstracts of papers that appeared during the year 1945 in 84 technical journals and patent gazettes in America, Britain and other countries. Two other volumes, one covering publications that appeared in 1946 and the other covering 1947, are soon to be issued, each at the same price. With the completion of Vol. III for 1947, the total number of abstracts will reach 2,362, which gives an idea of the research activity now going on in this field. The publisher says that the abstracts are explanatory and cover the material statements of the authors as completely as possible; and an inspection of the book gives one the impression that the abstractors have done a thorough job.

The paper abstracted are classified according to the subjects on which the researchers worked: gas generation for production of hydrogen and synthesis gas; the Fischer-Tropsch process; the Bergius process; the refining of crude oils, natural and synthetic; the analytical methods, instrumentation and associated engineering; and the organic and physical chemistry of the processes involved in the production of synthetic fuels. Those interested in this field will find here a mine of original sources.

Fina Expands Operation

Fina Petroleum Products, Inc., now has its head office at Blenstock House, 7 Blenheim Street, New Bond Street, London, W.1. The company has been expanding through the postwar acquisition of various companies and a long-term agreement with the Harris and Dixon group. Fina now has distribution throughout Great Britain.

Outside of London Fina has available ocean installations at Killingholme, Hull, Sunderland, Grangemouth, Preston, Liverpool and Aconmouth, with coastwise receiving depots at Poole, Oulton Broad, Caernarvon and Newport, and inland water bulk distributing points at Stourpoint, Gloucester, Leeds, Nottingham and Newark.

Forms Chemical Company

The Phillips Chemical Co. has been organized to conduct Phillips Petroleum Company's Chemical synthetic rubber and furnace-type carbon black operations. Key officers are Frank Phillips, chairman; K. S. Adams, president; Ross W. Thomas, executive vice president; Paul Endacott, Don Emery, G. G. Oberfell and R. C. Jopling, vice presidents. G. W. McCullough has been appointed vicepresident and general manager.

Phillips has leased the Cactus Ordnance Works ammonia plant at Etter in the Texas Panhandle and will also build a new ammonium nitrate plant at Etter. Present 70,000-tone capacity will be doubled. A plant will be built near Houston, Texas, for the manufacture of ammonium sulfate.

Buys Pennsylvania Forge

Tube Turns, Inc., has acquired the Pennsylvania Forge Corp., Tacomy, Pa., manufacturers of flanges and custom forgings. James S. Kerwin, president and W. T. J. Huggard, secretary and treasurer, and other officers will continue in their present capacities, and there will be no change in the personnel of the various departments. The business of the new subisdiary will continue to be operated under the name of the Pennsylvania Forge Corp. Tube Turns, Inc., has bought flanges from the company for several years.

World's Larges Pipe Bending Machine

The bending of pipe with diameters up to 100 inches has been accomplished by a new process announced by The M. W. Kellogg Co. The process eliminates slow segment welding which tended to suffer stress corrosion in service. The Kellogg method bends pipe in the hot state under hydraulic pressure. It is adaptable to small and large diameters, to thin and thick-walled pipe, and to short or long radius bends. It is currently being employed to fabricate 50-inch pipe bends for the carrier lines of large oil refining units.

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U. S. Refiners in Broad Program to Raise Capacity

(Continued from page 63)

ished in 1950 and will bring the daily capacity of the plant up to 30,000 barrels.

In the Chicago area some very large additions to refining capacity have been completed during the past year or are now in an advanced stage of construction. Within the past few months Standard Oil Co. (Indiana) has brought into operation the third of its large fluid catalytic cracking units, two at Whiting, Ind., and one at Sugar Creek, Mo., which have been under construction since 1946 and together add 75,000 barrels daily to the company's cracking capacity.

Another large modernization program now close to completion is that of Sinclair Refining Co. at East Chicago, Ind. The fluid catalytic cracking plant of 25,000 barrels daily charging capacity is now in operation. Other units including the propane deasphalting, phenol treating and MEK dewaxing sections of the lube oil plant will go into service before the end of this current year, as soon as the new large power plant is ready. The East Chicago installations virtually duplicate those at the company's Marcus Hook plant and are part of Sinclair's $165 million expansion program.

At East Chicago also Cities Service Oil Co. is well advanced on the modernization and enlargement of its refinery which is scheduled for completion in 1949 at a cost of $18 million. Among the principal additions are a fluid catalytic unit with gas recovery and delayed coking units. Other processing installations are gasoline treating, light ends recovery and gas purification units, the last named to be used in connection with LPG manufacture. Accessory features of the plant are a complete water supply, water treatment and sewage system comparable to that of a good-sized city and storage facilities for 650,000 barrels.

At Shell's Wood River, Ill., refinery which is always undergoing expansion the latest addition is a vacuum flashing unit of original design which was completed late in 1947 and processes 35,000 barrels daily of topped crude, separating it into light and heavy fractions. At the plant of Wood River Oil & Refining Co. a catalytic cracking unit of 8,500 barrels capacity is being constructed by Koch Engineering Co. At East St. Louis, Illinois, Bechtel Corp. is carrying out a modernization plan for Socony-Vacuum, which includes the addition of a crude distillation unit and thermal cracking equipment.

Construction plans reported for Phillips Petroleum Co. include a lubricating oil installation at its Kansas City, Kan., refinery and also a catalytic cracking unit which is to be the first of a series projected for the company's refineries. At Augusta, Kan., a fluid catalytic cracking unit is contemplated by Socony-Vacuum and at Coffeyville, Kan., the Cooperative Refinery Association has just completed a vacuum distillation unit and a new furfural solvent extraction plant constructed by Process Engineers.

In the Gulf Coast and Mid-Continent area which has long been one of the main refining sections of the country many large additions to plant capacity are under way. At the Baton Rouge, La., refinery of Esso Standard Oil Co. two vacuum pipe stills of 15,000 barrels a day are under construction as well as one 58,000-barrel atmospheric pipe still. These stills will add substantially to the crude throughput which already exceeds 200,000 barrels a day. They replace thermal cracking coils now used as distillation units. Increased cracking capacity is being effected through modification of existing units. In this way catalytic cracking charge capacity, which now amounts to 75,000 barrels a day, is expected to be increased 17,000 barrels daily. The refinery has three fluid catalytic cracking units. A substantial increase in light ends processing and polymerization facilities is under way. New lubricating oil finishing and wax producing facilities have come into operation during the past few months through expansion of two phenol treating plants and addition of a new MEK dewaxing unit. Wax facilities include a new propane de-oiling plant. The present expansion program is expected to reach completion early in 1949.

As part of the $40 million expansion program of Ethyl Corp. the company is further enlarging its manufacturing facilities at Baton Rouge. In addition to providing a larger output of tetraethyl lead this will increase its production capacity for sodium, chlorine and ethyl chloride. At the present time the company is the world's largest producer of ethyl chloride and among the largest producers of sodium. In addition to the increase in chemical output the company has completed a drum making plant which turns out 10,000 drums a month to supplement tank car shipments and is adding a development laboratory and pilot plant for use of ites technical staff. It also is building new terminals on the East and West Coasts and is planning a third at a location not yet announced.

At Norco, Louisiana, Shell is erecting a pressure distillate fractionating tower to increase processing capacity by releasing topping facilities now employed for processing cracked distillate.

Largest and most complete of its kind in the country is the advance application of the plant now under construction for Cit-Con Oil Corp. at Lake Charles, Louisiana. Cit-Con is a jointly owned subsidiary of Cities Service and Continental Oil Co. Its plant which is being edected at a cost of $35 million is designed exclusively for production of solvent refined lubricating oils and wax products. It is expected to go into operation sometime during 1949.

The plant is designed to produce 6,000 barrels daily of high quality 95 viscosity index lubricating oil and super quality lubes of 100 viscosity. Additional equipment will provide for the manufacture of refined crystalline wax. Among the units comprising the plant will be the largest furfural unit ever constructed, capable of circulating 30,000 barrels of solvent daily and of processing up to 71,000 barrels of oil per day. Another will be a Duo-Sol unit processing 9,700 barrels daily. Dewaxing of raffinate stocks will be by the MEK process. Clay treating will be used to improve color and stability and will be followed by acid treatment and percolation through bauxite clay. Construction of the plant is in charge of The Lummus Co. with the exception of the Duo-Sol unit which is being built by Max B. Miller Co.

At Port Arthur, Texas, The Texas Co. is installing desalting equipment, a large crude and vacuum unit and additional lubricating oil facilities. Alterations are being made to existing units to permit the running of a larger volume of sour crude and new units are being equipped to handle high sulful stocks. Gulf Refining Co. has under construction at its Port Arthur plant three modern crude distillation stills each with a daily capacity of 20,000 barrels and a 32,000-barrel polyform refining unit to improve the octane rating of gasoline.

As additions to the Beaumont, Texas, plant of Magnolia Petroleum Co. the M. W. Kellogg Co. is installing two vacuum distillation towers and The Lummus Co. is constructing a furfural solvent refining plant and an MEK dewaxing unit. These additions are expected to reach completion early in 1949.

Continuation of a broad expansion program by Humble Oil & Refining Co. provides for the expenditure of $16 million in 1948 on additions to its Baytown, Texas, plant. These include a pipe still of 45,000 barrel daily capacity and a phenol extraction plant to improve the quality and increase the yield of certain types of lubricating oils. A new benzol-methyl-ethyl ketone dewaxing unit was completed in February last. Construction will begin this year on large centralized machine shops for refinery maintenances.

At its Deer Park refinery in Houston, Texas, Shell is completing a major expansion project including a complete lube oil plant, a large power plant and a new control laboratory. The lubricating oil plant is estimated to cost $30 million and is expected to go into operation in July of this year. It will produce bright stock and neutrals for compounding into 2800 barrels per day of finished HVI, MVI, and LVI lubricating oils. The plant will process stocks from both East Texas and Yates crude.

When in full operation the lubricating oil unit will employ regularly 115 men. The plant will consist of two vacuum distillation units being constructed by The Lummus Co., a propane deasphalting and phenol extraction plant being constructed by M. W. Kellogg Co., a methyl ethyl ketone de-waxing plant, a contact clay filtration plant being constructed by The Lummus Co. Paved roads, railroads, electrical car lines and overhead pipe racks are being constructed by Fluor Corp. Intermediate oil storage is being

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constructed by Chicago Bridge and Iron Works of Chicago.

Pure Oil Co. is adding to its refinery at Smith's Bluff, Texas, an atmosphere distillation unit which replaces outmoded equipment and will provide cuts for processing lube stocks. A new lubricating oil plant is under construction and is expected to begin operation sometime in 1949. Other projects under way are a grease compounding plant, an oil drainage and recovery system and improved facilities for the use of employes.

Of potentially great importance to future refining development is the production of gasoline and other products from natural gas, shale and coal. This subject is discussed on other pages of this issue. The first plant designed to recover petroleum products from natural gas is under construction at the present time by Hydrocol Inc., New Brownsville, Texas. Stanolind Oil and Gas Co. is about to begin the erection of a similar plant which will draw its raw material from the great Hugoton gas field. Estimated cost of these refineries and accessory plants is more than $100 million. At Rifle, Colo., the United States Bureau of Mines is operating a pilot plant for the extraction of oil from shale and the product is being tested in various refineries. Some time must necessarily elapse before the effect of these ventures into new fields can be adequately measured.

In Oklahoma The Texas Co. is engaged in the enlargement and modernization of its refinery at West Tulsa in connection with which provision will be made for handling high sulfur crudes from West Texas. New facilities will include a crude desalting unit, new crude and vacuum distilling equipment, straight run gasoline desulfurization, a fluid catalytic cracker and a furfural refining unit for the production of diesel and fuel oils.

Sunray Oil Corp. has completely remodeled its refinery at Duncan, Okla., purchased last year from War Assets Administration and has installed a 20,000-barrel topping unit and a 20,000-barrel fluid catalytic cracking unit both of which are now in operation. In addition the plant includes a 10,000-barrel vacuum unit, a 5,000-barrel viscosity breaking unit, a 6-unit electrolytic desalting installation, a gas concentration unit and a polymerization unit for the production of butanes and propanes.

Cushing Refining Division of Midland Cooperative Wholesale has enlarged its refining facilities at Cushing by enlargement of its crude unit installation of a new thermal reforming unit and improvement of its Dubbs cracking unit by an additional reaction chamber and changes in the fractionator which will increase the topped crude charged capacity.

Much activity in the way of refinery construction is taking place in the Rocky Mountain district as a result of rising production in that area. A noteworthy development is the enlargement of Continental Oil Co's. refinery at Denver, Colo., which is now under way. The plant is designed to handle various types of crude including the high sulfur crudes characteristic of the region. The plant is built to a rated capacity of 7500 barrels daily of average crude but will handle up to 10,000 barrels of light gravity crude. The refinery incorporates catalytic cracking, gasoline stabilization, catalytic polymerization and facilities for the manufacture of LPG products, in addition to the existing refining facilities. The catalytic cracking unit, the first to be installed in any Colorado refinery, is of the Thermofor type licensed by the Houdry Process Corp. and will have a reactor charge capacity of 6,600 barrels a stream day. The design of new facilities and the entire construction work is being done by The Lummus Co.

Continental is also constructing a complete new refinery designed to process 7,500 barrels daily of high sulfur crudes at Billings, Mont., at an estimated cost of roundly $10 million. Special processing equipment was required in the design of this refinery to produce maximum yield of high quality gasolines and distillates from the low gravity, high sulfur crudes which will be processed. The processes incorporated are crude topping, catalytic desulfurization of straight-run gasoline and distillate, catalytic cracking, propane desalting of reduced crude, vapor recovery and gasoline stabilization facilities for a high percentage recovery of available liquified petroleum gas, and catalytic polymerization. Design and construction of the complete refinery is in charge of Jones and Laughlin Supply Co.

Another new refinery is being built at Billings by Carter Oil Co. It will be of 30,000 barrels daily capacity and will be equipped with atmospheric and vacuum pipe stills, fluid catalytic and bauxite finishing. The plant is expected to be ready for operation in the latter part of 1949 and its cost is estimated at $20 million.

Socony-Vacuum Oil Co. is modernizing its plant at Casper, Wyo., and enlarging it to 6,000 barrels daily capacity. A main feature of the reconstruction will be a thermofor catalytic cracking unit. Other additions include a new power plant, pump house equipment and facilities for the use of employes.

Standard Oil Co. of Calif. announced recently that its capital expenditure of $33 million for refinery expansion during 1948 would include the initial unit of a new refinery at Salt Lake City, Utah. A subsidiary company, Salt Lake Refining Co., will operate this which will have a daily capacity of 25,000 barrels and will be supplied with crude by a pipe line 182 miles in length leading from the fields of Western Colorado. Another Salt Lake City plant, Utah Oil Refining Co., is expanding the capacity of its plant to 25,000 barrels daily.

On the West Coast the Standard Oil Co. of Calif. has undertaken the reconstruction of its Bakersfield plant including the addition of crude distillation and cracking units in addition to auxiliary equipment which will double its capacity to 20,000 barrels daily by late 1949.

At the company's Richmond and El Segundo refineries which have been substantially enlarged in the past few years installations recently completed have resulted in a material increase in crude running capacity.

To Build Petrochemicals Plant

Returning from a trip through Europe recently H. R. Austin, president of the M. W. Kellogg Co., announced that Imperial Chemical Industries will erect a cracking plant for the production of ethylene and propylene. The plant will be built at Wilton, England, with the Kellogg Company doing the engineering and design work and supervising erection. Capacity of the new plant will be 7,400 barrels daily of naphtha which is to be brought in from the Middle East.

H. R. Austin

Ethylene and propylene to be produced will be used in the production of detergents to reduce British importations of fats and oils. In this respect it will supplement the Shell and Manchester group plants now being built in the United Kingdom. Other end products of the plant include solvents, pharmaceuticals and raw materials for plastics. The Wilton plant as a whole will cost $68 million and is only a part of the $520 million expansion program of I.C.I.

Discussing the European refinery construction program Mr. Austin said that in France the current 4-year plan will require some 216,000 tons of steel which must be supplied by French industry. When the program is completed France will have a capacity of 345,000 barrels of crude daily compared with a 1948 capacity of about 200,000 barrels daily. In Belgium he said that negotiations are in progress for the erection of a 30,000 barrel plant which will do much to make that country self-supporting for refined oils.

Although British refineries are operating at prewar rates the nation still does not produce its own requirements because of the advance in mechanization and consequent increase in consumption. Although the war-time pool is ended it is not expected that brand competition will be aggressive this year. British law still limits civilian driving to 90 miles weekly and effective measures are being taken to prevent violations.

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World Wide Refinery Expansion Planned

(Continued from page 65)

crude. It will be provided with a vacuum tower to run Challaco bottoms to asphalt whenever required by market demands. This unit will also be able to produce a number of solvents for oil extraction, paint manufacture and dry cleaning.

Delayed coking, fluid catalytic cracking, alkylation, polymerization and lead blending units will make up the processing plants. Since all of the kerosene from the topping plant will be marketed as well as some of the straight run gas oil, most of the charge for the cat cracker will be derived from the delayed coking unit. Aviation gasoline produced is to have 120 octane rating and motor fuel 72-76, both after leading.

The Kellogg Company is to provide and erect the auxiliary installations including power house, water recirculation and cooling system, loading racks, tanks and fire system. Cost of the processing units is estimated at $15 million U. S. Construction work and auxiliary equipment is figured at $16 million U. S. Construction is to start in the first quarter of 1949.

The refinery will be connected with Buenos Aires harbor by a pipe line, some 11 miles long, to deliver crude oil to the refinery from YPF tankers.

The San Lorenzo combination will be integrated by a topping unit, viscosity breaker, fluid catalytic cracker, polymerization and LPG units. It is designed to run Comodoro Rivadavia crude and produce mainly 72-76 octane motor fuel with the addition of tetraethyl lead. This unit, figured at a cost of $10 million U. S., will bring the capacity of the San Lorenzo refinery to 28,500 barrels per day of crude with a yield of more than 40 percent gasoline.

The 9,500 barrel combination unit for the Mendoza refinery located at Lujan de Cuyo is estimated to cost $6 million U. S. and will include a topping plant, viscosity breaker for highly paraffinic Barrancas crude, a fluid catalytic cracker and LPG unit. These additions will raise the daily capacity of YPF plants from 58,000 to 107,000 barrels. YPF is preparing shortly to ask tenders for constructing a new lubricating

Fractionating column fabricated in England by G. A. Harvey and Co. for Shell's new Cardon refinery in Venezuela.

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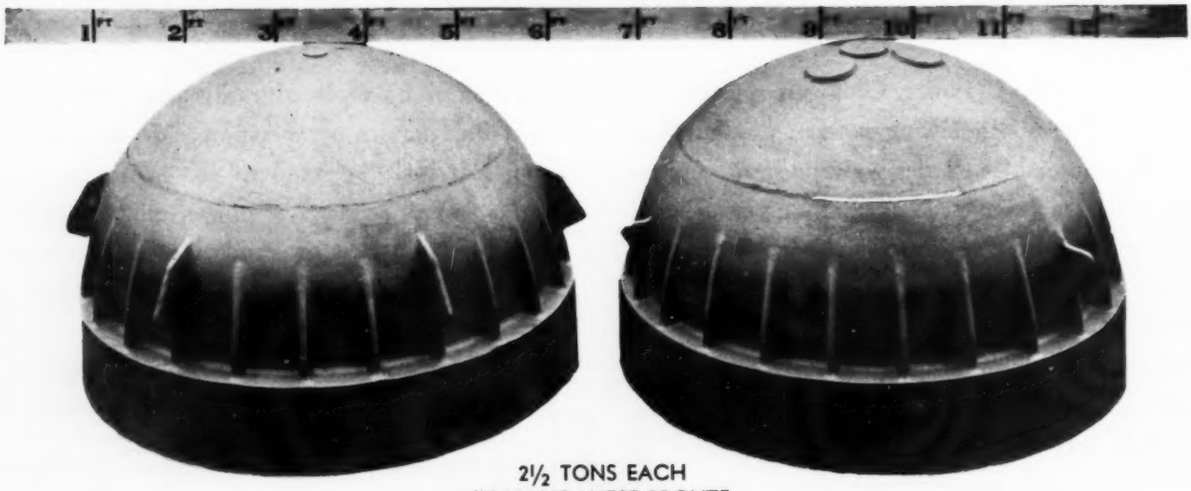

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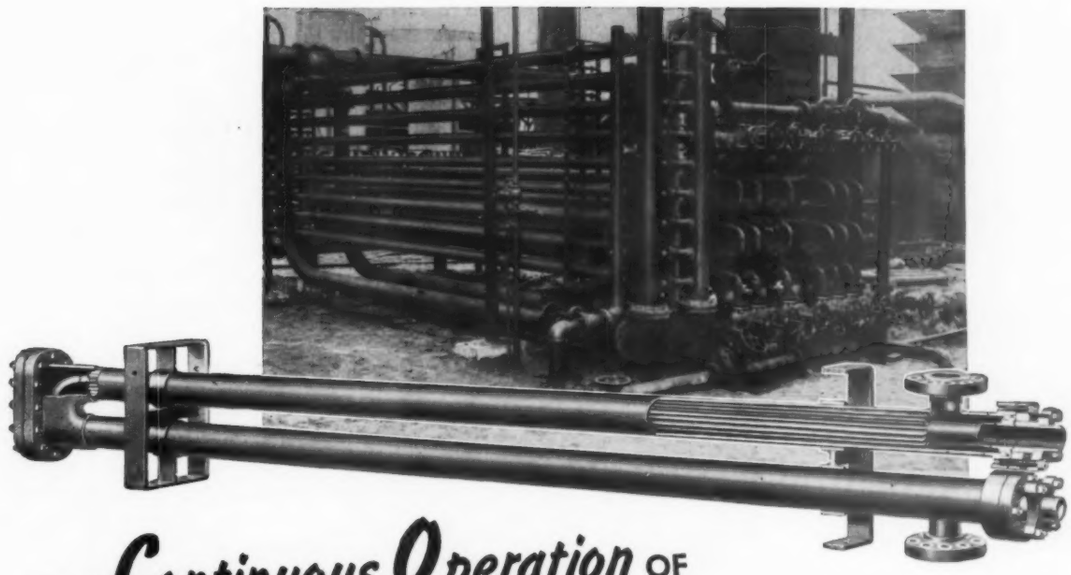

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HEAT EXCHANGERS

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oil plant for its La Plata refinery. It will include a two stage vacuum distillation unit of 9,500 barrels daily capacity together with the propane deasphalting, solvent treating and dewaxing equipment necessary to a complete operation. A contract has been awarded to Catalytic Construction Company for a 25,000-barrel topping plant to be installed at La Plata.

Privately owned refineries, among which the more prominent are those of Standard Oil Company of Argentina, Ultramar, Diadema, Ferrocarrilera, Condor, Cia General de Asfaltos, Lottero and Papini, are making improvements to increase the capacity and efficiency of their plants. These changes range from a million dollar expenditure and the doubling of capacity by one of the smaller companies to the replacement of obsolete equipment and installation of new processing units. The refiner is introducing a new two stage vacuum still, propane deasphalting and solvent extraction units to replace acid treating equipment. Another is doubling its lube oil capacity and a third is installing an Isoflow furnace and additional fractionating equipment to enlarge its cracking capacity. In general they are preparing to meet the trend toward higher octane gasoline and improved lubricants.

Argentina's neighbor, Bolivia, has had plans completed for a year or more for two refineries to be built under the direction of Foster-Wheeler Corporation. Construction has been delayed by inability to obtain delivery of material but is now about to begin. One of the two new plants will be a combination unit of 5,000 barrel capacity at Cochabamba and the other a 3,000-barrel topping plant at Sucre. Completion of the Sucre plant is expected in 1949 with the other to follow in 1950.

In Ecuador the refinery of Anglo-Ecuadorian Oilfields Ltd. at La Libertad is being enlarged from 2,000 to 4,000 barrels daily. The work will be completed within another month or two. Chile still has in contemplation the establishment of a refinery of 8,000 to 10,000 barrels capacity but thus far the project has not advanced beyond the planning stage.

Brazil is another country that is anxious to expand its refining facilities. The National Petroleum Council has authorized the construction of a 10,000-barrel plant in or near Rio de Janeiro. A proposal for a plant in Bahia to handle the crude production of that district has received favorable consideration and discussions have been under way with international oil companies regarding other projects. Difficulty in financing larger plants under the terms of Brazil's petroleum law appears to be the main obstacle to a broad expansion of refining activities.

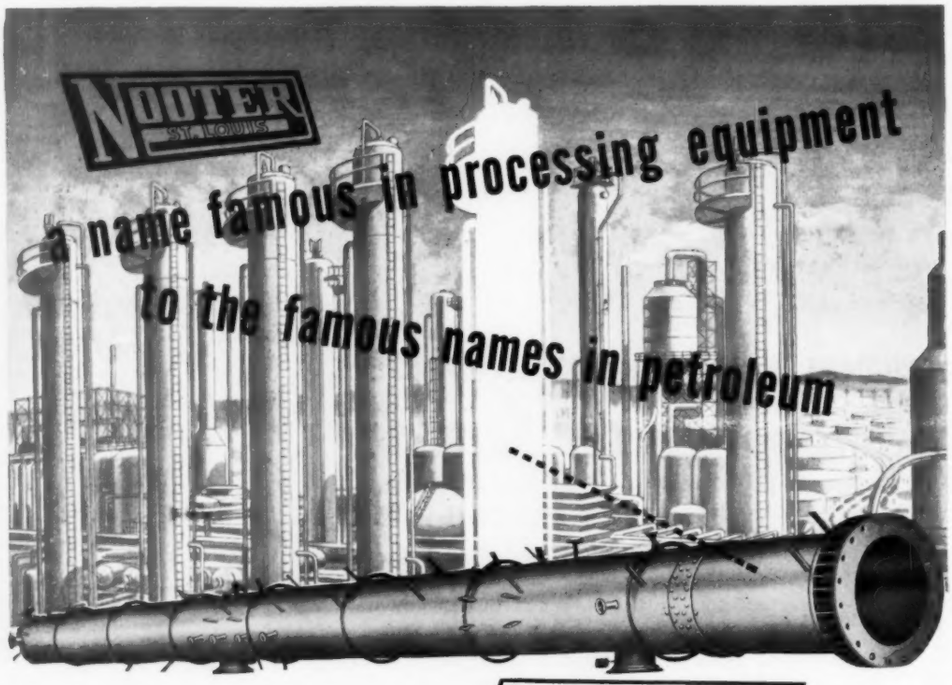
Venezuela's extensive program of refinery extension is the subject of a special article on other pages of this issue.

Across the Atlantic the refinery expansion program in the United Kingdom, according to a statement of the Ministry of Fuel has grown to the point where it will require an investment of some $400 million but progress toward implementing the plans that have been drawn has been relatively slow during the past year. This has been due largely to the fact that official authorization is necessary before construction can be undertaken and the government apparently has felt that other uses for steel and building materials were more urgent than the needs of the oil industry. There is also, it must be admitted, a feeling of insecurity among investors over the possibility that the oil industry may be nationalized although assurances have been given that no such step is contemplated at present.

Largest of the projects that have been held in abeyance is the Fawley refinery of Oil Company subsidiary of Anglo-American which is to have a capacity of 120,000 barrels daily and is calculated to cost $150 million or more. Plans for this plant have been in a finished state for a year or more. Just recently it was reported that the government had extended tentative permission for the commencement of construction.

As a result of additions made to the Llandarcy refinery of Anglo-Iranian Oil Co. Ltd. that plant will have a throughput of over 30,000 barrels daily in the coming year and will reach

(Continued on page 111)



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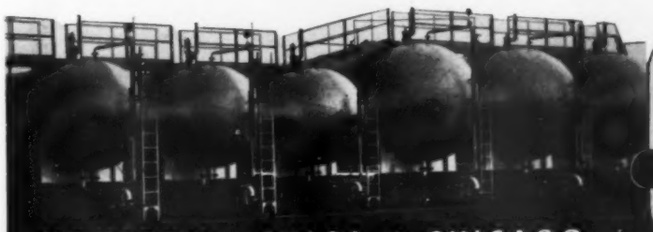

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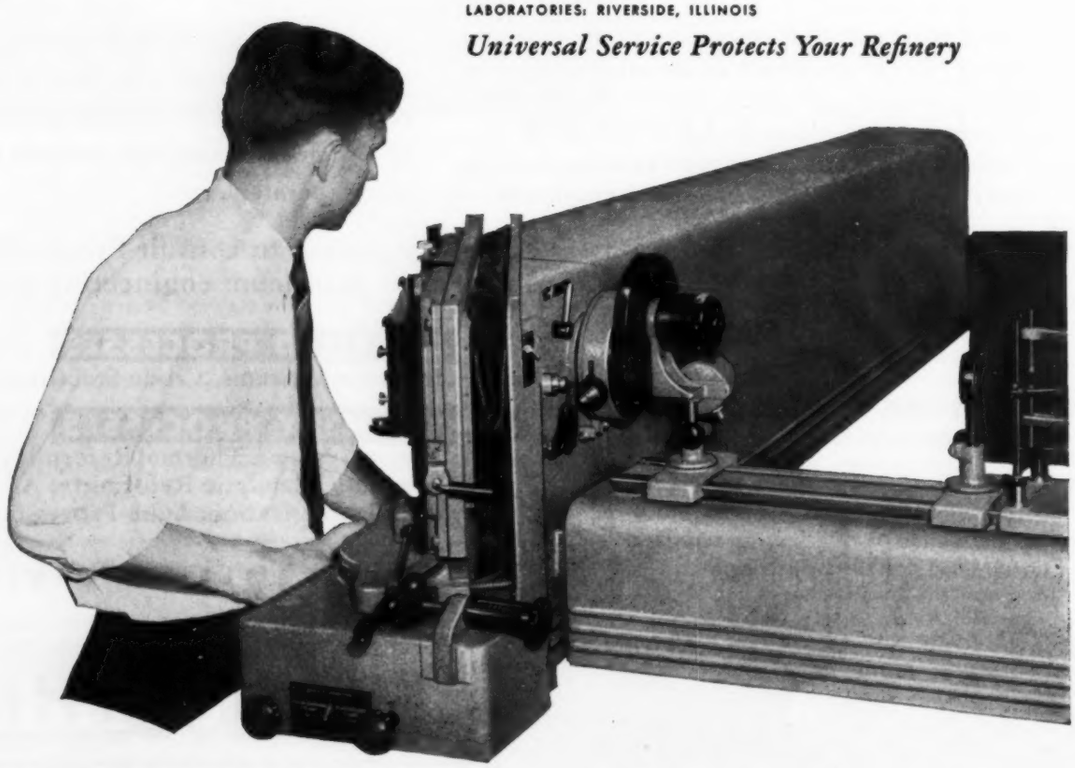

(Continued from page 106)

63,000 barrels by early 1950 when the program is completed. Plant facilities for the production of lubricants are being greatly extended.

Grangemouth refinery, a property of Scottish Oils Ltd., subsidiary of Anglo-Iranian, is to undergo modernization and enlargement which will raise its daily capacity from 7,000 barrels to 20,000 barrels. New installations will include a catalytic cracking plant charging 5,000 barrels daily and a full line of improved processing equipment. The two undertakings will call for the investment of $65 million or more. A chemical plant will be erected adjoining Grangemouth by Anglo-Iranian in partnership with Distillers' Corporation Ltd. for the production of raw chemicals from petroleum. It will require an investment of $20 million or more.

Announcement has been made within the past few weeks of a third refinery to be built on the Isle of Grain in Kent. Its capacity is to be 50,000 barrels and its reported cost will be $120 million. Details of the plant have not been made public but it is understood to be a joint enterprise of Anglo-Iranian and Gulf Oil Corporation. The two share owhership of the Kuwait oil concession and it is assumed that the refinery when completed will operate on Kuwait crude.

Intention of the Shell Group to construct a large refinery in England has been known for some time but lack of government authorization for the large amount of steel required has delayed action. It is now made known that this obstacle has been removed and that the work will shortly get under way. Completion of the project, however, is not expected until 1953. Recent purchase from London and Thames Haven Oil Wharves Ltd. of nearly 700 acres indicates that the plant will be built on that site.

Aerial view of the Anglo-Iranian Oil Company's refinery at Llandarcy, South Wales.

In the meantime construction is proceeding on a new blown asphalt plant of Shell Refining and Marketing Co. Ltd. at Shell Haven and on extensions to the Shell Haven specialty plant for the production of petroleum solvents which will result in a production of 8,000 barrels per month of these products. Construction of the new refinery at Stanlow has begun and the plant is expected to be ready for operation by 1952. The Stanlow plant of Shell Chemical Manufacturing Co. Ltd. is nearing completion and it will soon be producing a wide range of solvents.

During the past year Shell purchased from the

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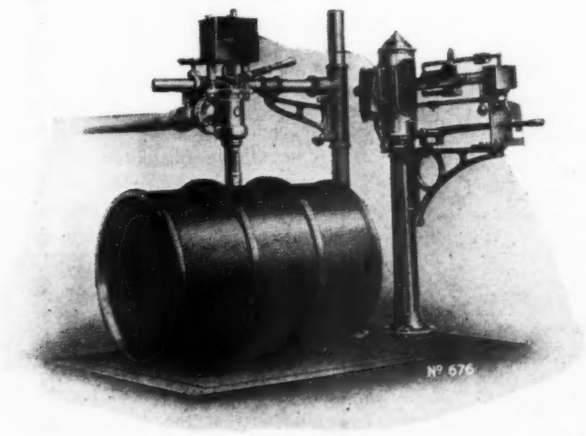

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government the high octane gasoline plant at Leysham, Lincolnshire, built for military use. It has been revamped to handle Middle East crude and is handling 30,000 barrels daily, producing motor fuel, diesel oil and fuel oil.

A Foster-Wheeler vacuum distillation uhit installed at the plant of Manchester Oil Refinery Ltd. is handling about 2,200 barrels daily of Texas crude and has added to the capacity of the lubrication plant. Substantial progress has been made on the Partington works of Petrochemicals Ltd. adjacent to the Manchester Ship Canal. Improvements have been made in the Caterole process employed at this plant and its effective capacity has been increased from 50,000 to 50,000-75,000 tons. Berry, Wiggins & Co. Ltd. is now operating two Foster-Wheeler units at its plants with an annual capacity of one and a quarter million barrels, making all types of bitumens, lubricating and fuel oils. A large extension of capacity at the Kingsnorth refinery is planned with full distillation and refining plant for handling Middle East crude. Trent Oil Products Ltd. has decided to build a refinery at Lynnmouth on the north-east coast.

On the continent steady progress is being made in the reconstruction of French refineries in accordance with a plan that will raise capacity well above its pre-war figure as described on other pages. In Holland California-Texas Oil Co. Ltd. is erecting at Pernis, near Rotterdam, a new refinery designed to process 20,000 barrels daily of Arabian crude. Its equipment will include a two stage vacuum unit of 20,000 barrels daily capacity, a thermal reformer handling 6,500 barrels daily, a Dubbs thermal cracker of 6,400 barrels daily capacity, a non-selective polymerization unit capable of producing 900 barrels daily of polymers, an Edeleanu SO_2 extraction plant of 1,600 barrels daily capacity together with necessary treating and finishing facilities. The plant is scheduled for completion in 1950.

Production at the Pernis refinery of the Royal Dutch Group has been raised to 23,000 barrels daily or 50 percent above its pre-war capacity as the result of improvements recently made. This plant handles the crude from the Schoonebeck field developed during the war.

Italy, like France, is planning for a refining industry materially larger than it had in the pre-war period. Reconstruction of pre-war plants is proceeding and several of them are in operation at part of their former capacity. Work on the Naples plant of Socony-Vacuum which was almost completely demolished is under way and the various units are expected to be ready for operation at the end of 1948 or early in 1949. Some of the Italian companies have strengthened their position by agreements with international corporations covering their crude supply and enabling them to hasten rehabilitation of their plant and marketing facilities. A number of applications for authority to construct new refineries have been filed including one for a plant of substantial size at Genoa.

From countries within the orbit of Soviet control very little information has been permitted to emerge. Reports from the Soviet Union itself are that rehabilitation of its oil industry is proceeding according to the five year plan under which production was to be restored to approximately the pre-war level by the end of this year. Refinery reconstruction and extension was scheduled to keep pace with the gain in production and presumably is doing so.

In Romania the decline of the oil industry continues under the policy imposed upon the government which prevents domestic companies from obtaining materials and equipment for the restoration of fields and refineries and is leading to the virtual confiscation of the properties of foreign owned companies such as the large plants of the Royal Dutch-Shell, Standard Oil Co. (N. J.) and Unirea.

Disturbed conditions in the Middle East have stayed progress on projects for new refineries in that area. Plans for the erection of two big plants at the Mediterranean terminals of the Trans-Arabian and Mid-East pipe lines have had to be shelved temporarily because it has been impossible to determine when these lines can be completed. At Haifa, Palestine, work on the enlargement of the plant of Consolidated Refineries Ltd. which was to double its through-

(Continued on page 116)

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The "Master" Contract – GOOD OR BAD?

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6. ***Simplified field administration and accounting***
   ... removing the necessity of duplicate facilities by several contractors in the field and the concurrent extra work at home offices
7. ***Elimination of competition for local labor***
   ... expediting construction and insuring minimum labor costs
8. ***Uniform labor policy at job site***
   ... with resultant improvement of man-hour efficiency
9. ***Maximum economy in use of all labor at job site***
   ... through the flexible interchange of crafts from one unit to another
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    ... by dispensing with duplicate utility lines and housing for tools, supplies and labor
11. ***Reduced tool expense***
    ... through full time use of all tools on various units

by
Warren L. Smith
Vice President of The
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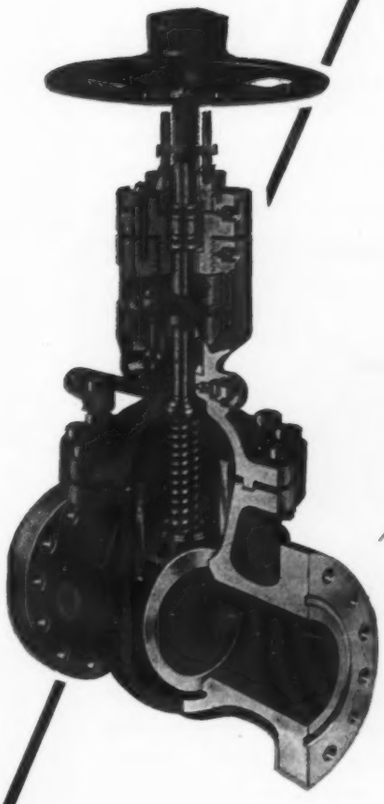

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(Continued from page 112)

put to 80,000 barrels daily has been suspended and the refinery has been closed down for the past several months. Other additions proposed at Haifa comprised a plant for producing 2,500 barrels daily of lubricants and included a vacuum distillation unit of 13,500 barrels daily capacity, a 4,500-barrel propane deasphalting unit, a 5,800 barrel Furfural plant and a 2,800 barrel clay treating plant.

Other refineries in the Middle East area continue to add to their facilities. Throughput capacity at the Abadan, Iran, plant of Anglo-Iranian Oil Co. Ltd. has now reached 500,000 barrels daily. Work is about to begin on a complete lubricating oil plant at this refinery to produce 1,000 barrels of lubricants daily for the company's own use and for distribution in Iran and Iraq. The plant will include a Furfural unit, an MEK dewaxing unit and a clay treating unit, together with a packing plant. A catalytic cracking unit of 30,000 barrels daily capacity is also to be installed at Abadan.

Several additions to process plant capacity are being made at the refinery of Bahrein Petroleum Corporation, on Bahrein Island, Persian Gulf, together with auxiliary facilities such as utility equipment, tankage and housing. New process equipment will include a thermal reformer of 6,500-barrel capacity with lead sulfide treating facilities which will permit the raising of the octane level of gasoline produced and an 18,000-barrel vacuum still which will charge atmospheric reduced crude and will result in improved fuel oil quality and increased production of gasoline. Recently an asphalt plant has been put into operation at Bahrein charging vacuum reduced crude to produce 50,000 tons a year of asphalt.

Good progress is being made in restoring refineries in the Far East which were heavily damaged during the war. The two big plants of Standard-Vacuum and Royal Dutch-Shell, at Palembang and Pladjoe in Sumatra, are back in operation. The latter was running 47,000 barrels daily at the end of last year, working partly on imported crude. In Java only two small plants have been returned to operation but in Borneo production is close to its pre-war level.

The refinery at Lutong is working at capacity handling 22,000 barrels daily and in the Balikpapan field two distillate units are in operation. At all these refineries many replacements and additions are still to be made in order to put them into condition satisfactory to their operators. Construction of the new refinery planned at Miri is waiting until the difficulty in obtaining materials and equipment is lessened.

In Australia the plant of Bitumen and Oil Refineries Ltd. at Sydney which is owned jointly by California Texas Oil Company Ltd. and Australian interests has been completed. It is equipped with a 3,000-barrel two-stage distillation unit and a battery of converters for blowing vacuum distilled asphalt residuum. It will operate on synthetic crude from Bahrein and will produce 50,000 tons yearly of asphalt in addition to by-products.

Shell Oil Co. of Australia Ltd. put on stream in May its bitumen plant at Clyde, New South Wales, which is designed for a yearly product of 35,000 tons of asphalt. This is in addition to the company's refinery which processes 6,000 barrels daily.

AFTER more than 38 years' service with Standard Oil Co. (Indiana), Dr. O. E. Bransky, assistant general manager of the manufacturing department, will retire Sept. 1. The manufacturing department in the general office at Chicago has been reorganized, and Dr. W. J. McGill, manager of the Whiting, Ind., refinery, was promoted to the new position of superintendent, manufacturing operations in the Chicago office. J. C. Ducommun succeeded Dr. McGill as manager at Whiting.

Dr. Bransky joined the company in 1910 as a research chemist at Whiting. In 1931 he became manager of the Whiting refinery, and in 1934 assistant general manager of manufacturing.

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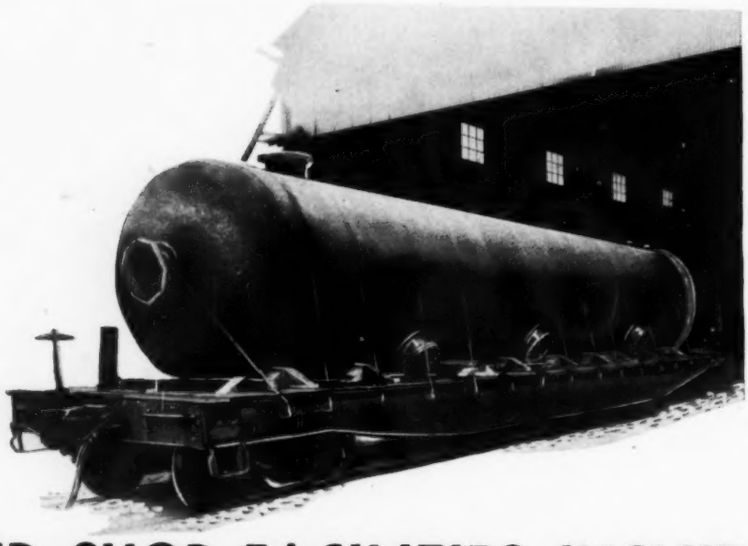

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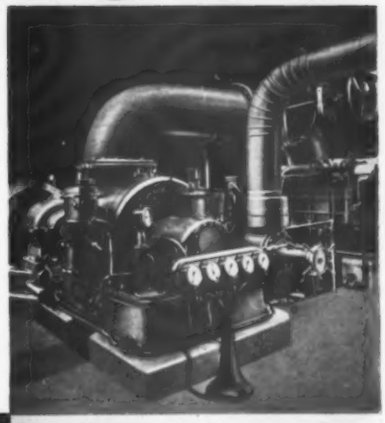
Wide Range - All Types

The Brotherhood Steam Turbine illustrated on the right is a 750 B.H.P. Bleeder unit installed in a Paper Mill and operates at 6,000 R.P.M. Steam is drawn off, in quantity regulated by the demand, at 35 lb. per square inch during its passage through the Turbine and the remainder led to the Condenser.



The unit on the right is a two crank two stage forced lubricated double acting Air Compressor coupled to a Brotherhood two crank compound forced lubricated Steam Engine.

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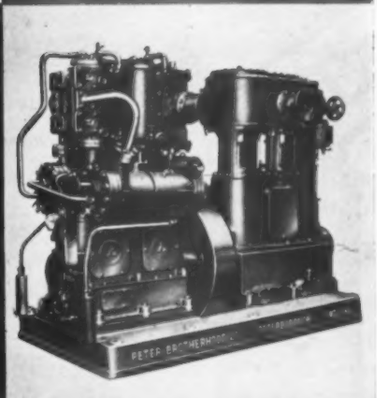
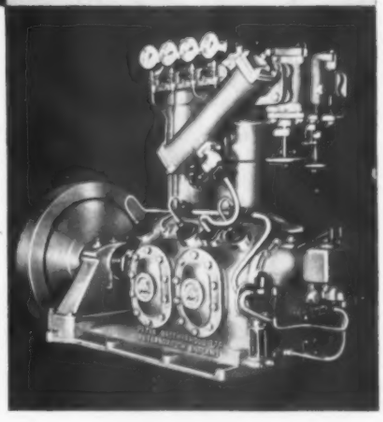
Air and Gas COMPRESSORS



REFRIGERATING PLANT

The Brotherhood range of Refrigerating Compressors includes single and double acting machines having one or more stages for use with Ammonia, CO_2, Freon, SO_2, and Methyl Chloride.

Also Diesel Engines 200-500 B.H.P. Steam Engines and Plant to Customer's own design.



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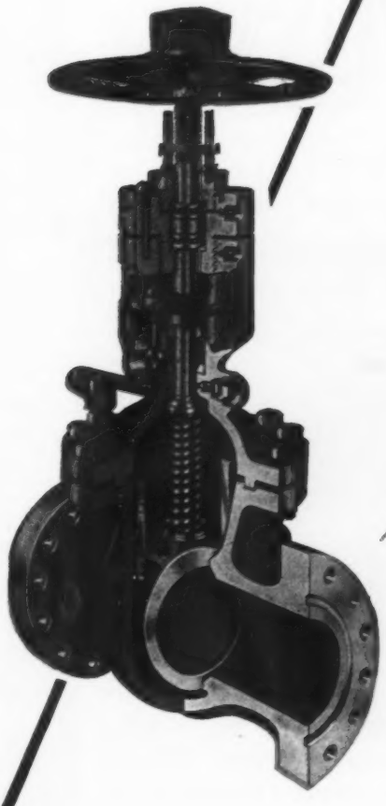

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(Continued from page 112)

put to 80,000 barrels daily has been suspended and the refinery has been closed down for the past several months. Other additions proposed at Haifa comprised a plant for producing 2,500 barrels daily of lubricants and included a vacuum distillation unit of 13,500 barrels daily capacity, a 4,500-barrel propane deasphalting unit, a 5,800 barrel Furfural plant and a 2,800 barrel clay treating plant.

Other refineries in the Middle East area continue to add to their facilities. Throughput capacity at the Abadan, Iran, plant of Anglo-Iranian Oil Co. Ltd. has now reached 500,000 barrels daily. Work is about to begin on a complete lubricating oil plant at this refinery to produce 1,000 barrels of lubricants daily for the company's own use and for distribution in Iran and Iraq. The plant will include a Furfural unit, an MEK dewaxing unit and a clay treating unit, together with a packing plant. A catalytic cracking unit of 30,000 barrels daily capacity is also to be installed at Abadan.

Several additions to process plant capacity are being made at the refinery of Bahrein Petroleum Corporation, on Bahrein Island, Persian Gulf, together with auxiliary facilities such as utility equipment, tankage and housing. New process equipment will include a thermal reformer of 6,500-barrel capacity with lead sulfide treating facilities which will permit the raising of the octane level of gasoline produced and an 18,000-barrel vacuum still which will charge atmospheric reduced crude and will result in improved fuel oil quality and increased production of gasoline. Recently an asphalt plant has been put into operation at Bahrein charging vacuum reduced crude to produce 50,000 tons a year of asphalt.

Good progress is being made in restoring refineries in the Far East which were heavily damaged during the war. The two big plants of Standard-Vacuum and Royal Dutch-Shell, at Palembang and Pladjoe in Sumatra, are back in operation. The latter was running 47,000 barrels daily at the end of last year, working partly on imported crude. In Java only two small plants have been returned to operation but in Borneo production is close to its pre-war level.

The refinery at Lutong is working at capacity handling 22,000 barrels daily and in the Balikpapan field two distillate units are in operation. At all these refineries many replacements and additions are still to be made in order to put them into condition satisfactory to their operators. Construction of the new refinery planned at Miri is waiting until the difficulty in obtaining materials and equipment is lessened.

In Australia the plant of Bitumen and Oil Refineries Ltd. at Sydney which is owned jointly by California Texas Oil Company Ltd. and Australian interests has been completed. It is equipped with a 3,000-barrel two-stage distillation unit and a battery of converters for blowing vacuum distilled asphalt residuum. It will operate on synthetic crude from Bahrein and will produce 50,000 tons yearly of asphalt in addition to by-products.

Shell Oil Co. of Australia Ltd. put on stream in May its bitumen plant at Clyde, New South Wales, which is designed for a yearly product of 35,000 tons of asphalt. This is in addition to the company's refinery which processes 6,000 barrels daily.

AFTER more than 38 years' service with Standard Oil Co. (Indiana), Dr. O. E. Bransky, assistant general manager of the manufacturing department, will retire Sept. 1. The manufacturing department in the general office at Chicago has been reorganized, and Dr. W. J. McGill, manager of the Whiting, Ind., refinery, was promoted to the new position of superintendent, manufacturing operations in the Chicago office. J. C. Ducommun succeeded Dr. McGill as manager at Whiting.

Dr. Bransky joined the company in 1910 as a research chemist at Whiting. In 1931 he became manager of the Whiting refinery, and in 1934 assistant general manager of manufacturing.

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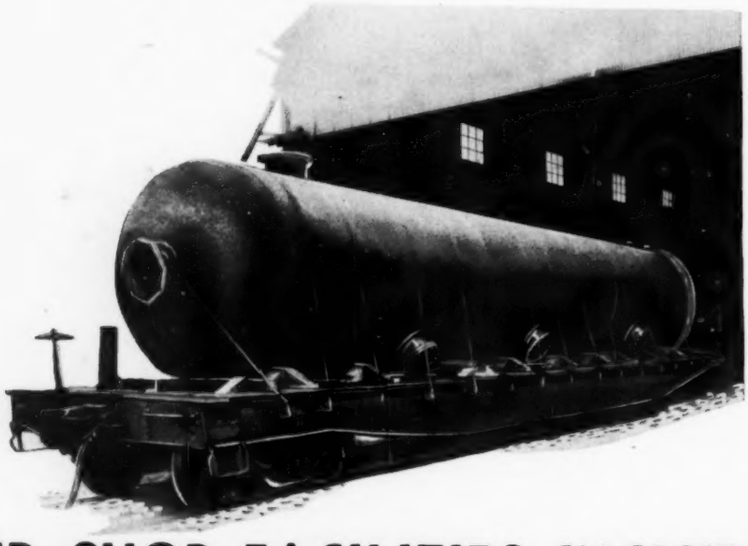

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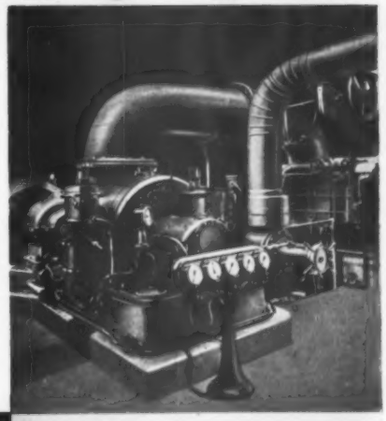

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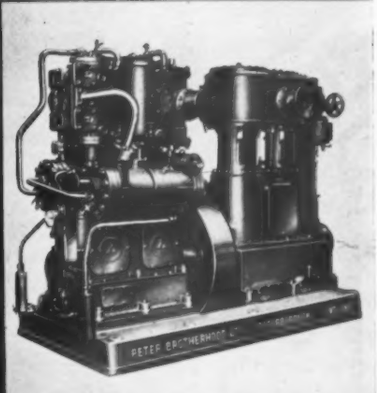

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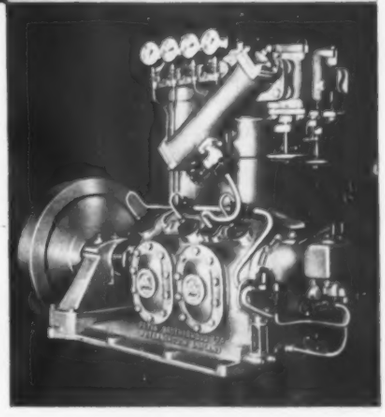

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Propane Decarbonizing Towers

Two propane decarbonizing towers, each 12 feet in diameter, 75 feet in length and 2⅝ inches in wall thickness have recently been completed at The M. W. Kellogg Shops in Jersey City. They will be shipped overseas for installation in two foreign refineries. The rare combination of plate thickness and vessel diameter made the fabrication job noteworthy.

The unusually thick 2⅝ inch wall of these two vessels was required to withstand a high internal pressure—approximately 500 pounds per square inch—and additionally, to provide ⅛ inch of corrosion allowance due to the presence of active sulfur compounds in the reduced crude oil which will be processed. The vessels were tested hydrostatically to 900 pounds per square inch. To provide an ample margin of safety they were designed with a safety factor of five.

The principal material of construction was a high tensile strength carbon-silicon steel which, with a tensile strength of 70,000 pounds per square inch, is approximately 30 percent stronger than usual pressure vessel steels. Precise welding control was necessary to prevent cracking of the weld or metal adjacent to the weld and to develop a proper weld strength. The thickness of the plate, too, required approximately twenty-four layers of weld metal in each joint, each layer deposited after careful removal of the slag from the previous layer. All principal joints were welded automatically by a continuous submerged-arc process. The welding of the external and internal attachments was performed manually using a ferritic low-hydrogen type of electrode developed during the war for the welding of armor plate without cracks.

Interior of large propane decarbonizing towers during fabrication at Kellogg shops.

Inspection of welds included the radiographing of all main butt joints, using a 400,000 kva X-Ray unit; and magnetic particle inspection of all strength welds not radiographed. Test plates were tested destructively to verify joint strength and ductility. Finished towers were stress relieved.

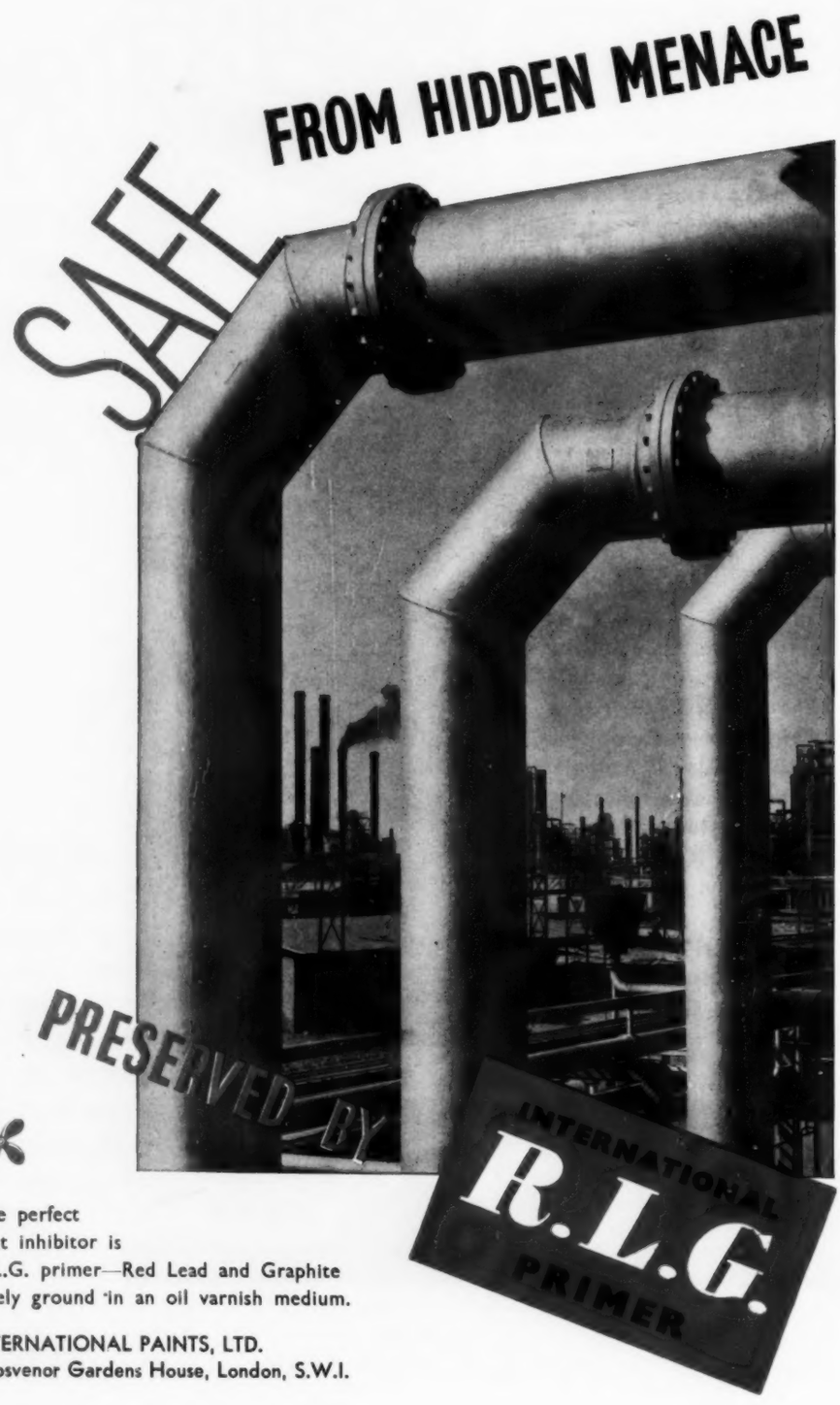
Two Topping Units for Argentina

Catalytic Construction Co., has been awarded contracts to supply engineering and equipment for two 25,000-barrel topping units for Yacimientos Petroliferos Fiscales de la Argentine. Materials are to be shipped in the third quarter of 1948 on the $2,500,000 operation.

T. Elwood Webster, president of Catalytic Construction, announced that his company had $31 million in orders for construction and maintenance on its books on May 15 last. The company is a subsidiary of Houdry Process Corp.

Public Relations Manual

A new "Public Relations Manual for the Oil Industry" for use of oil companies and trade associations in the oil industry is being distributed by the Oil Industry Information Commerce, 670 Fifth Avenue, New York. The manual discusses oil industry and oil company public relations opportunities from every viewpoint and shows how to take advantage of the opportunities. It is a 24-page, two-color 8½ by 11-inch brochure.



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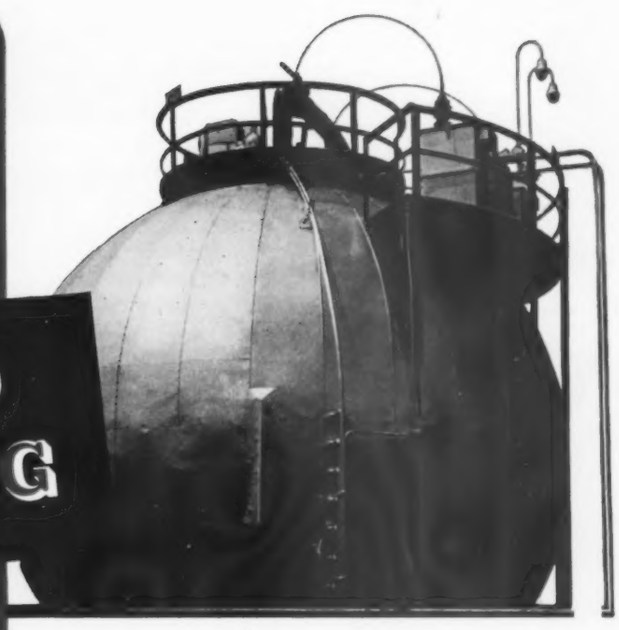

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PR-414

Petrochemicals Paint

A new company called Styrene Co.-Polymers, Ltd., has been formed by joint agreement between the Berger group of companies, paint manufacturers, and the Petrocarbon Ltd.-Petrochemicals, Ltd. group of companies whose petroleum chemicals plant is nearing completion at Partington, near Manchester, England. The new company is to build a new factory near Partington, Cheshire, for the production of co-polymers of styrene, thereby taking advantage both of the Berger styrene patents and of the Catarole process, operated by Petrochemicals Ltd., which will produce monomeric styrene from which the co-polymers are manufactured.

The development of styrene co-polymer media is the direct result of research undertaken by Lewis Berger & Sons, Ltd. The idea of obtaining compatibility between polyvinyl compounds and drying oils by polymerizing the monomer in the presence of drying oil is not altogether new. It was investigated in Germany and America before the war but with little success. After six years of research and manufacturing experience, Lewis Berger is now producing a synthetic resin co-polymer media which can be applied wtih equal success to produce the high-quality gloss enamels and flat wall paints. Not only do enamels manufactured from styrene co-polymers involve a considerable saving in linseed oil, but it is claimed that the finish, consisting of a tough, flaxible and durable film, has is own specific properties, in many respects superior to those of more conventional types. Styrene co-polymer enamels, either glossy or matt, can be made for air-drying decorative, or various air drying and industrial stoving finishes.

The monomeric styrene which will be supplied to Styrene Co-Polymers, Ltd., by Petrochemicals, Ltd., will be produced by two processes: by the dehydrogenation of ethyl benzene and by the separation of an o-xylene/styrene mixture by extractive distillation. The ethylene and benzene, which are reacted to form ethyl benzene, and the o-xylene/styrene mixture are the products of catalytic cracking of the Catarole charging stock.

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WRITE FOR LITERATURE

JOHN ZINK COMPANY

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Builds Big Butane Tanks

Seven large butane storage tanks recently were fabricated at its Dallas, Texas, plant by Butane Equipment Co. The tanks were built for the account of The Lummus Co., New York, for installation at Barnsdall Oil Co's. new gasoline plant at Benton, La.

Each of the butane tanks is 11 feet in diameter by 63′ 5″ and has a water capacity of 45,000 gallons. They are believed to be among the largest shop fabricated storage tanks built in the Southwest. Standing in the tank as pictured during fabrication are John W. Pratt of Butane Equipment Co's. petroleum engineering department, Albert D. White, manager of the company, and Basil Noble, assistant manager and director of production.

Buys Two Coastal Vessels

Sun Oil Company has put into service two new coastal tankers. Built for the Navy as auxiliary oilers, the tankers were purchased from the U. S. Maritime Commission and converted to Sun's specifications at Bethlehem Steel Company's shipyards at Alameda, California. The vessels have been renamed the M. S. Mystic Sun and the M. S. Maumee Sun. Each is 220 feet long and has a capacity of approximately 500,000 gallons of gasoline. Powered by 860 horsepower diesel engines, they have a rated speed of ten knots.

Expands Research

A 40 percent increase in current facilities at The Texas Company's research laboratories in Beacon, New York, will be provided by the construction of three new buildings at that location. These will be completed within a year and will provide 55,000 square feet of additional floor space. A new engineering building will contain laboratories for volatility, lubrication and combustion studies. A chemistry building will contain 18 entire laboratories for the further development of new lubricants. The third new building will provide office space and required services for carrying on the activities of the above units. The new buildings are a part of a research expansion program projected over the next ten years.

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This 1000-line Federal *AIR WING* Tire advertisement appeared in 294 newspapers April 1, 1948.

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This pioneer introduction of the new-type Federal AIR WING Tire is typical of Tide Water's progressive outlook . . . of Tide Water's long established *habit* of leading the field with new developments in the petroleum industry.

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R. S. Dead Weight Tester
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R. S. Pressure Hydrometer Jars
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Completing Newhall Gasoline Plant

Nearing completion at Newhall, California, is the 40-million-cubic-foot gasoline recovery plant being built for Barnsdall Oil by the Refinery Maintenance Co. of Compton, Calif. The plant will feature a new rich-oil stabilization system.

Refinery Maintenance Co. was organized in 1943 to handle maintenance work for refineries in California. After the war activities were expanded in 1946 to include straight labor contracts in construction of oil refineries, natural gasoline plant and other types of industrial construction in addition to maintenance work. In 1947 the company further expanded into design and engineering of turn-key projects for the oil and gas industries, of which the Barnsdall project at Newhall was the first. Also in the summer of 1947 the company opened an office in Houston, Texas, to serve the Mid-Continent and Gulf Coats.

Contracts were recently awarded to Refinery Maintenance for a 20-million-cubic-foot gasoline recovery plant near Bloomfield, New Mexico, for the Southern Union Gas Company and a 12-million-cubic-foot gasoline recovery plant in Crockett County, Texas, for Continental Oil Co. and associates. Among the projects undertaken in the Mid-Continent was a recycling plant for Western Natural Gas Co. at Three Rivers, Texas, and a large gas dehydration plant for McCarthy Chemical Co. near Beaumont, Texas.

F. J. Buckner, president and founder of Refinery Maintenance, was formerly associated with the Fluor Corp., C. F. Braun & Co., and Arthur G. McKee in an engineering capacity. H. M. Nelly, Jr., vice president, was associated with the M. W. Kællogg Co. and more recently was manager of the petroleum division of the J. F. Pritchard Co. He joined Refinery Maintenance in 1947. J. R. McGee, secretary-treasurer, has been active in the oil industry for 20 years, principally in Texas and the Gulf Coast. W. G. Palmer, who has more than 35 years' experience in the contracting business, is chief engineer.

New Varec Eastern Sales Manager

Lewis W. Klockner, Jr., has been named as the new eastern sales manager for The Vapor Recovery Systems Co. of Compton, Calif. Sales and engineering headquarters for this area remain at the same address, 30 Church Street, New York City.

W. D. MANZ has been made manager of Sunray Oil Corporation's catalytic cracking plant at Duncan, Okla. The plant was recently purchased by Sunray from the War Assets Administration. During the war Mr. Manz was superintendent of the plant. He came to that position from Rock Island Refining Co., of which he was general manager.

H. M. Nelly, Jr.

R. L. Johnson now is superintendent of the Duncan plant, having been transferred from another Sunray plant. R. C. Underwood has been made assistant superintendent, and E. C. Smith maintenance superintendent.

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Bogota, Colombia

To Build Five Tankers

A program to build five of the world's largest tankers at a cost of approximately $30,000,000 was announced recently by T. S. Petersen, president of Standard Oil Co. of California. They will have a deadweight capacity of 28,000 tons and a volume capacity of 240,000 barrels. Largest of the big tankers now operated by Standard or its subsidiaries has 18,000 tons deadweight capacity and can carry 150,000 barrels. Plans are to construct the vessels at the Quincy, Mass., yards of the shipbuilding division of Bethlehem Steel Company. Delivery is scheduled for 1950 and 1951.

"The basic reason for our decision to build these ships is our anticipation of a greater worldwide movement of petroleum products," Mr. Petersen said. "We are looking forward to the necessity for increased imports to the United States to meet the country's growing oil needs. Conditions prevailing at the time of delivery will determine the use to which they will be put, but our present plans are to use them to transport crude oil from Venezuela to the United States."

The new ships will be 595 feet long, 84 feet wide and 44 feet deep, with a service speed of 16¾ knots. They will be powered by high-pressure steam turbines delivering 12,500 horsepower, with double reduction gears and a single screw. Fully radar-equipped, the ships will have the latest in high-speed equipment for loading and unloading. The vessels will be owned and operated by Foreign Tankship Corp., wholly-owned Standard of California subsidiary.

Equips All Tankers With Radar

The Atlantic Refining Company will install Raytheon radar equipment on its entire fleet. Installations on the 21 ships will cost the company approximately $304,000. The SS Robert C. Tuttle will be the first Atlantic tanker to be radar-equipped when it enters drydock for its periodic overhauling next August 20. Subsequent installations will be made on each of the other vessels as they are drydocked. The entire program will be completed in a year. Atlantic was the first oil company to have radar equipment placed on an ocean-going commercial tanker. The installation was made on the SS Atlantic Mariner in the summer of 1946 at Mobile, Alabama.

Heads Corrosion Research

W. H. Stewart, Sun Oil Co., Beaumont, Texas, was elected chairman of the Corrosion Research Project Committee of the Natural Gasoline Association of America at a meeting of the group in Dallas May 26. He succeeds T. S. Bacon, Lone Star Producing Company, Dallas, who has served as chairman since the committee was formed in June, 1944. F. A. Prange, Phillips Petroleum Co., Bartlesville, was elected vice chairman and succeeds M. E. Holmberg of the same company.

At the recent meeting plans were made for continuing the work for another year with a view to extending the studies of the fundamentals of corrosion for a period of four years. Three research programs at the University of Texas were approved.

Continental Purchases War Plant

Continental Oil Company has purchased the toluene plant erected in 1943 at Ponca City, Oklahoma, by Defense Plant Corporation and operated for the government during the war by Continental. Initially used to manufacture nitration grade toluene employed in the production of war bombs, the plant later was converted to the production of toluene as a blending agent for 100-octane aviation gasoline. It was closed in September 1945 and remained inactive until the latter part of 1946, when it was leased by Continental to be used periodically in the manufacture of gasoline and other products. Purchase price of the plant is reported as approximately $175,000.

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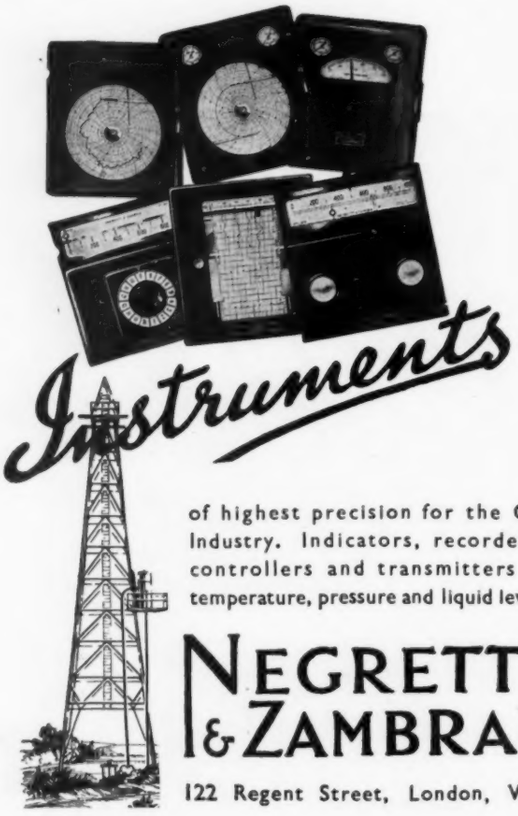

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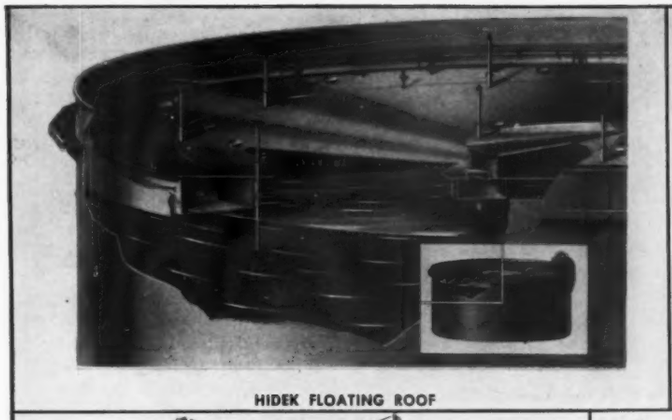
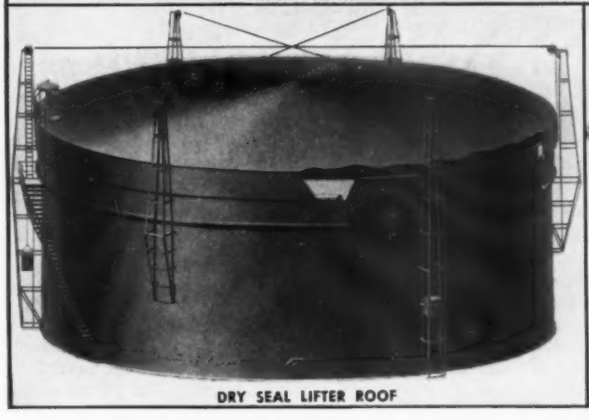


HIDEK FLOATING ROOF

DRY SEAL GAS HOLDER



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Executives and engineers responsible for the efficient storage and marketing of petroleum products will find it to their advantage to investigate General American Wiggins Conservation Structures.

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J. A. V. Watson

R. J. Turner

J. A. V. WATSON, O.B.E., and R. J. Turner have been appointed general managers respectively of the motor oil and industrial oil interests in the United Kingdom of C. C. Wakefield & Company. Mr. Watson joined Wakefields in 1929 and was only 21 when he took over control of the company's six-figure annual advertising account. During the late war he served as chief test pilot to Britain's Air Transport Group. Mr. Turner joined the firm in 1915 and after serving in World War I he held the position of export manager until he transferred to industrial sales in 1945. He is vice president of the British Institute of Export and a member of the Oil Distributor's Emergency Council.

Signs Navy Contract

Caltex Oil Products Co. has contracted to sell 98.5 million barrels of oil products to the U. S. Navy for delivery in the Persian Gulf over the next five years. Contract embraces 60 million barrels of fuel at $1.48 per barrel; 28.5 million barrels of diesel fuel at $2.00 per barrel, and 10 million barrels of motor gasoline at $4.3915 per barrel.

Tank Car Of Shale Oil Shipped

A tank-car load of 6,369 gallons of crude shale oil—the first bulk shipment of oil from the Bureau of Mines' new oil shale demonstration plant near Rifle, Colorado—is undergoing preliminary tests in the laboratories of Universal Oil Products Co., at Riverside, Ill. The shale oil will be "fractionated" by Universal, after which the Union Oil Co. will conduct cracking and other refining studies in its California laboratories. Smaller lots of shale oil have been sent previously to research laboratories. The Bureau's oil shale demonstration plant, a part of the $60,000,000 synthetic fuels research and demonstration program, has been in operation several months.

Shell Builds Detergents Plant

The first unit of what may become a complete plant for making oil-derived synthetic detergents used in household and industrial soaps, cleansers and emulsifying agents is being constructed by the Shell Chemical Corp., in Wood River, Ill. Raw materials will be received from Shell Oil's adjacent refinery. The new unit will manufacture an intermediate chemical used in making finished detergents. Shell Chemical now operates plants at Dominguez, Martinez and Pittsburg, California, and Houston, Texas.

Beacon Moves Offices

Beacon Petroleum Co. moved its offices on June 1 to the Wright Building, 115 West Third Street, Tulsa. Former offices were in the Hunt Building. Beacon is engaged in the marketing of liquefied petroleum gases.

Marketing Merger in U.K.

A combination of marketing interests in the United Kingdom and Eire has been effected between Trinidad Leaseholds, Ltd., and California Texas Oil Co. As a result the name of Regent Petroleum Co., Ltd., former Trinidad subsidiary, has been changed to Regent Assets Co., Ltd., and The Texas Oil Co., Ltd., formerly the marketing organization of California-Texas, has become Regent Oil Co., Ltd. The Texas Co. (Ireland) Ltd. is part of the joint undertaking and continues to operate in Eire.

REX LANE has been appointed chief engineer for Warren Petroleum Corp. in charge of construction and maintenance. Mr. Lane first entered the oil industry in 1928 as an engineer for Sinclair Prairie Oil & Gas Co. He joined Warren in 1943.

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A special stainless steel makes liners both corrosion and abrasion resistant. Centrifugally cast and honed to a mirror-like finish, they have precisely-controlled hardness for maximum wear resistance.

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Cages are scientifically designed to provide correct ball lift and clearance. They are heat-treated and flame-hardened to withstand pounding and spinning action of ball.

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Seats are individually lapped in a special machine to insure perfect fit with ball. Each ball and seat is vacuum tested to guarantee its perfection.

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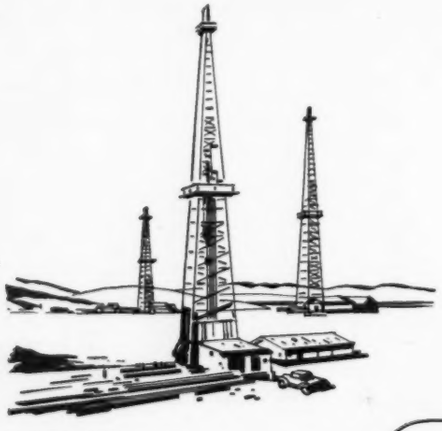
RESISTANCE TO WEAR. Trucks that do heavy duty need parts that resist wear. Axles, bearings, gears and universal joints are only a few of the truck parts that are made better with alloy steels.



CORROSION AND HEAT RESISTANCE. Oil field operations require parts that give the utmost in resistance to corrosion and wear. Places where alloy steels are used include drill bits, pumps, elevators and swivels.

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An exceptionally high ratio of strength to weight is just one of the important advantages of Republic Alloy Steels. They resist wear better than any other material . . . and their resistance to corrosion and heat keeps equipment in good condition, reduces repair bills.

A wide range of uses includes those pictured at the left, as well as gears, shafts, locomotive forgings, power drills, stud bolts, wrenches . . . in fact, all parts that must be hard and strong.

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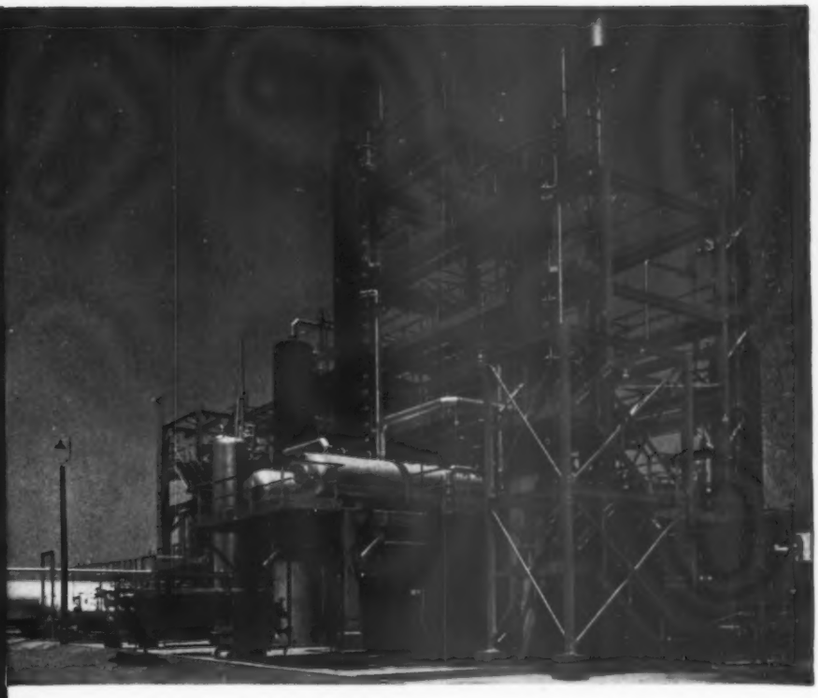

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Ethyl benzene
Ethyl ether and isopropyl ether
Ethyl, isopropyl and other alcohols
Explosives and smokeless powder
Fats and fatty acids
Filtrol fractionated lubricating oils
Formaldehyde
Glycerine and glycols
Home burning oils
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Maleic anhydride
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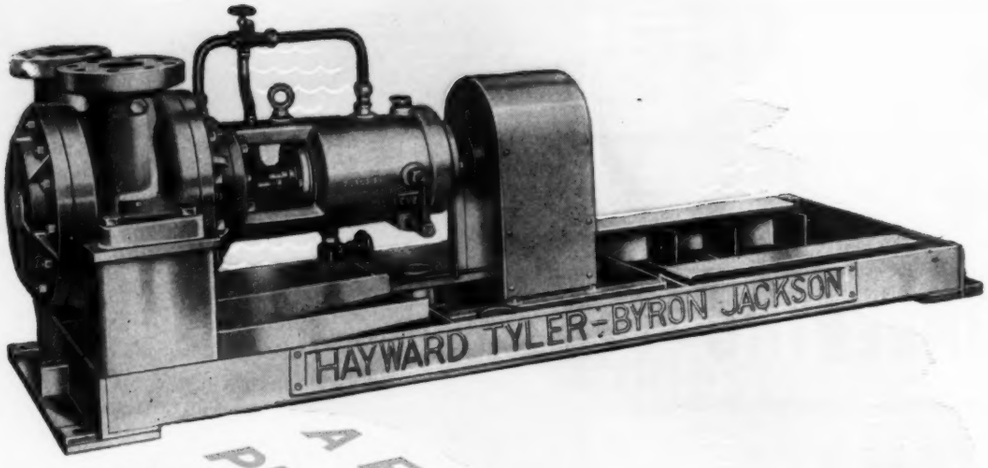
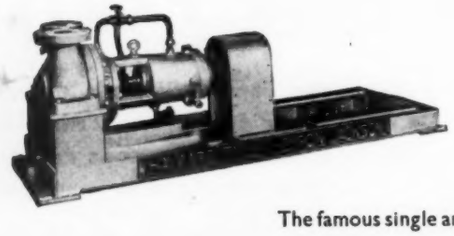


A FAMOUS PUMP NOW ALSO MADE IN ENGLAND



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Centre line support. Mechanical seal or water cooled oil sealed stuffing box with split quenching gland. Renewable shaft sleeve in special materials. Water-cooled oil lubricated ball bearings. The Range has the maximum number of common parts, and the British and American are interchangeable.

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For speeds up to	4,000 R.P.M.	3,600 R.P.M.
Pressures in lbs. per square inch up to	500	650
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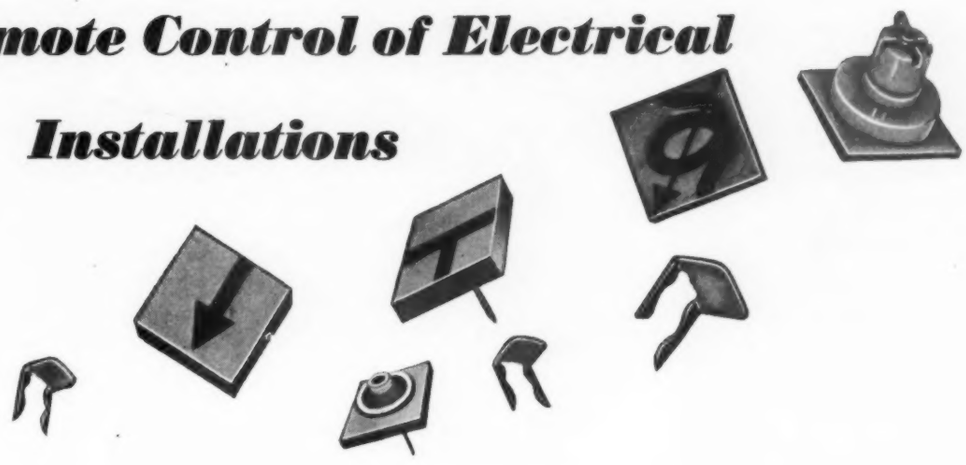
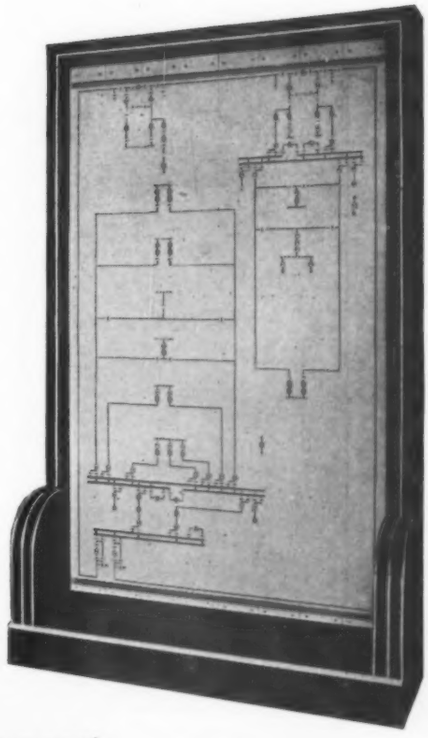


A complete pictorial record of electrical connections throughout an area can be built up and periodically adjusted to show any changes by means of the mosaic diagrams used with Supervisory Remote Indication and Control Equipment. These diagrams consist of small square pieces of plastic material with electrical line connections or apparatus symbols depicted on their surface. They are mounted on pierced mounting strips by means of simple clips and any required representation of electrical connections can thus be built up to suit the circumstances. Where necessary the circular centre portion of the moulded squares can be rotated so that, for example, the state of connections of circuit breakers and isolators can be shown. Should changes occur such as the addition of new stations or the re-arrangement of feeders, the appropriate section of the diagram can be revised quickly and conveniently to suit the new conditions.

These ingenious wall diagrams are but one example of the many ways in which A.T.M. Supervisory Remote Indication and Control Equipment can be applied to the needs of industrial, commercial or public utility establishments.



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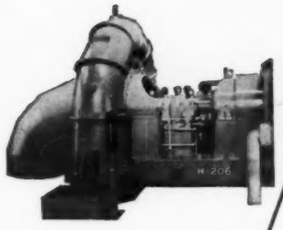

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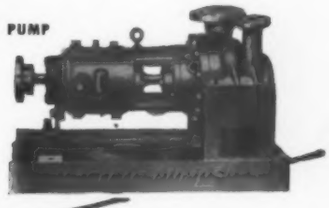
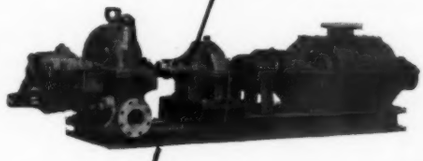
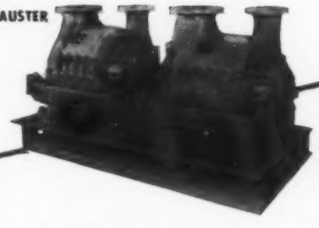




• ROOTS-CONNERSVILLE—ROTARY POSITIVE EXHAUSTER



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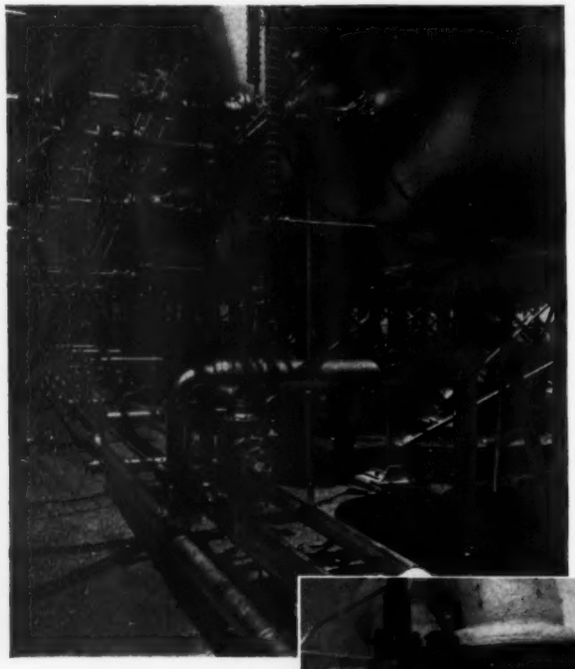
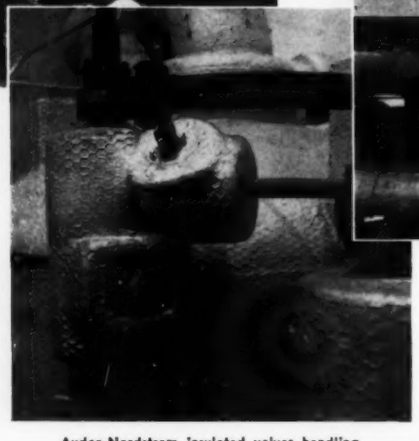
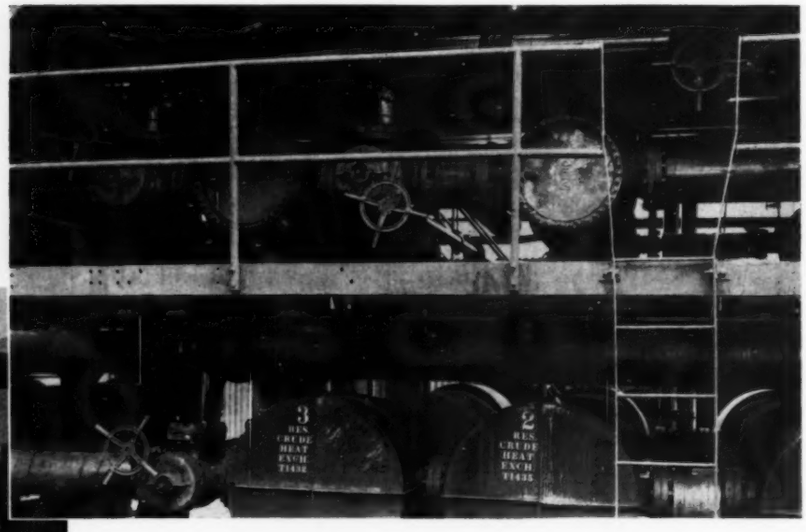


Audco-Nordstrom valves handling light fractions



Audco-Nordstrom insulated valves handling propane at —30 F



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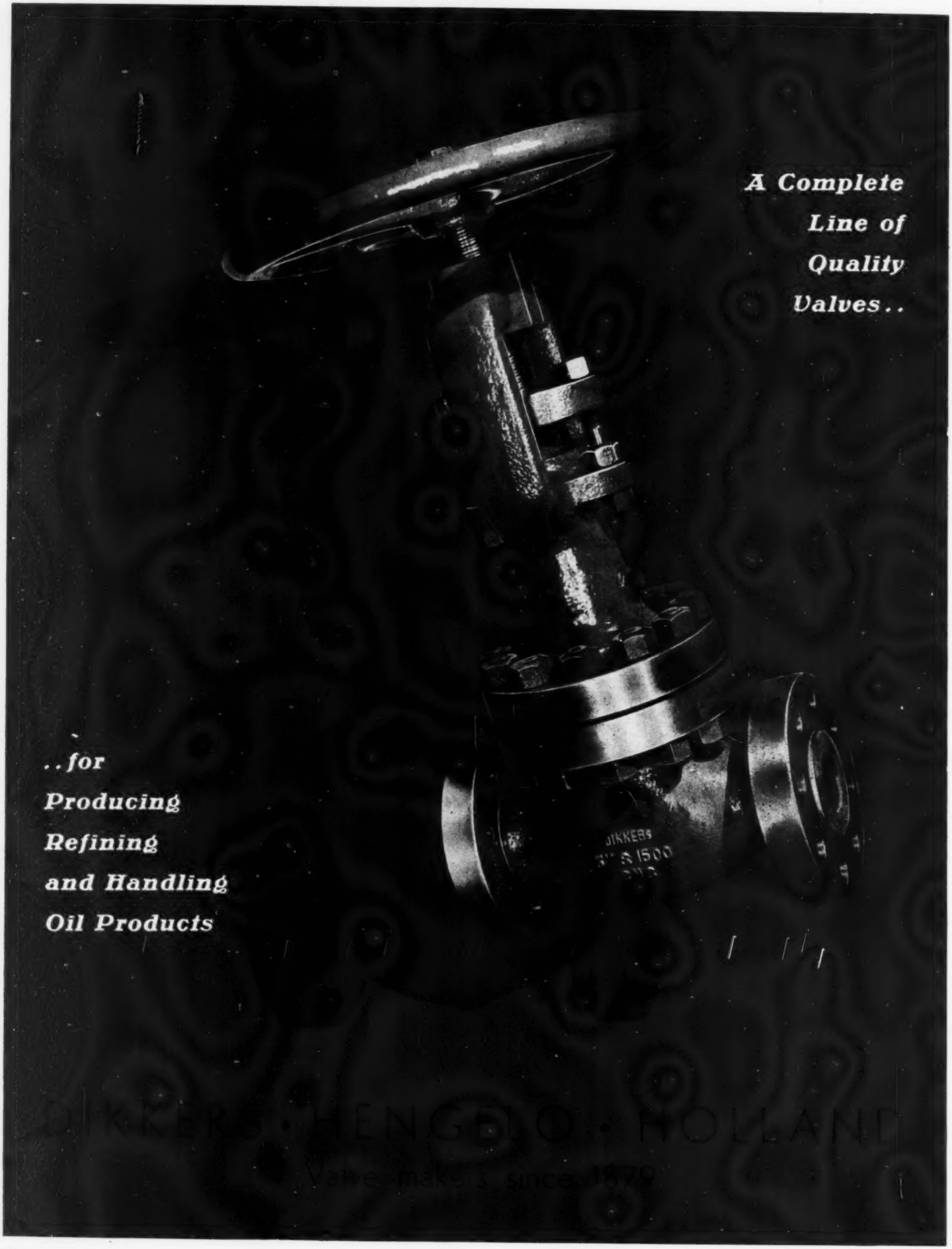
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